ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

VOL. XLIII. No. 25.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 401
New [illegible]-ft. Span Stone Arch Bridge for the [illegible] R. R., at Bellows Falls, Vt. (illustrated) 402
Methods and Results of Surveys and Borings for Mohawk Ship Canal Route (illustrated). 402
Corliss Triple Expansion Engine and Direct-Connected Alternator at the Paris Exposition (with cut-off gear plate and other illustrations)..... 405
Notes from the Engineering Schools 407
The Designs for the Proposed Memorial Bridge Across the Potomac River at Washington, D. C. 411
Some Gaugings and Measurements at the Break in the Austin Dam (illustrated) 412
The Disinfection of Water Mains with Chloride of Lime 412
The Heaviest Locomotive in the World; Pittsburg, Bessemer & Lake Erie R. R. (illustrated)..... 413
Center Plates and Side Bearings for Freight Cars (illustrated) 413
Combination Ballast and Gondola Cars; Wisconsin Central Ry. (illustrated) 415
EDITORIAL NOTE 408
The Work of the Massachusetts Gas and Electric Light Commission.
EDITORIAL:
The Proper Manipulation of Tests of Cements; A Symposium 408
LETTERS TO THE EDITOR 409
Curves for Determining the Weights of Roof Trusses (illustrated)—Hardwood Pavements in the City of London and in Australian Cities—A Conversion Formula for Retaining Walls (illustrated)—The Silt Deposit Behind the Austin Dam and the Relation of Silt Deposits to Storage Reservoirs—Methods of Interpolating Contour Points (illustrated).

CIVIL SERVICE EXAMINATIONS FOR DRAFTSMEN will be held July 10 to 14, inclusive, in all cities having a local board of examiners. On July 10 and 11 the examination will be for structural steel draftsmen to be employed in the Navy Department at Washington, D. C. On July 12 to 14 the examination will be for architectural and structural steel draftsmen to be employed at Boston, Mass. Persons who desire to compete for these positions should at once apply to the U. S. Civil Service Commission, Washington, D. C., for application forms 304 and 375, which should be properly executed and promptly filed with the commission.

THE RAISING OF A BRIDGE SPAN 250 ft. long and weighing 550 tons will form a part of the improvements being made on the Boston bridge, which spans the Youghiogheny River between Elrod station, on the Baltimore & Ohio R. R., and the little town of Boston, on the Pittsburg & Lake Erie. The bridge is 735 ft. long, but only the eastern end is to be raised. It is to be lifted 23 ft. in order to connect with a viaduct being built over the tracks of the Baltimore & Ohio to enable the cars of the Youghiogheny Street Ry. Co., running from McKeesport to West Newton, to cross the railway above grade. Mr. Herman Laub, M. Am. Soc. C. E., of Pittsburg, is the engineer in charge of the work. The lift is to be made with four jacks, worked by compressed air. At each lift of the jacks the bridge will be raised 1 ft. The jacks will be reset and another lift made. As the bridge goes up the piers will be raised at the same time. A ring of steel will be clamped around the top of the piers and filled in with concrete. By the time the bridge is raised the piers will have reached the desired height. Piling is being driven in the river on which to rest the trestles, which will support the jacks and the bridge in its upward journey. The bridge is of the cantilever pattern. It is estimated that it will take about one week to raise the bridge to its required height and another to connect it with the viaducts at either end.

BALLAST FOR RAILWAY TRACK is being made the subject of investigation by the American Railway Engineering & Maintenance of Way Association. The inquiry will include the best character of each kind of ballast, and particularly the cost of renewing ties in each kind. Also the methods of handling, the cost of different varieties of ballast (including excavation, screening, burning and other operations, and loading, handling, unloading, placing under the track, and the final surfacing and dressing up), and the system of keeping account of ballasting.

UNIFORM RECORDS OF TIE RENEWALS are aimed at by the American Railway Engineering and Maintenance of Way Association, and the association is now sending to all railways blank forms of the style recommended by the Committee on Ties at the annual meeting in March. The blanks are in tabular form, it being intended to have a line devoted to the records of each division, but the record is defective in that it does not include any mention of the kind of timber, or the approximate life of the ties, so that no comparisons can be made as to the life of ties of different woods or in different kinds of ballast. A list of the tabular headings is given below:

1. Division.
2. Miles of road operated; first main track.*
3. Additional main track.
4. All tracks, including sidings.**
5. Average number of ties in track, per mile of road.
6. Number of ties renewed, per mile of road.
7. Ratio of renewals (6) to ties in track (5).
8. Total number of ties renewed.
9. Gross tonnage passing over first main track, per mile.
10. Gross tonnage per tie renewed.
11. Maximum weight of locomotive and tender, tons.
12. Maximum weight of fully loaded freight cars.
13. Weight of rail, per yd.
14. Percentage of main track curved.
15. Tie-plated.
16. Ballasted.
17. Laid with treated ties.
18. Average cost at distributing point; treated ties.
19. Untreated ties.
20. Total cost of renewals per mile of first main track.†
21. Per mile of all tracks.†

*This mileage used for computing averages in (9) and (20).
**This mileage used for computing averages in (5), (6) and (21).
†Total cost to include cost of switch and cross ties, tie-plates and spike plugs, but not the labor of placing in the track.

CREOSOTED PINE TIES are giving excellent service on the Houston & Texas Central Ry. Mr. G. A. Quinlan, Vice-President, informs us that in January, 1874, there were placed in the yard at Houston about 50 bull-pine or loblolly-pine pole ties, 7 x 9 ins., 9 ft. long, which had been treated at Galveston with creosote or dead oil of coal tar. An examination of these ties made a short time since, in company with Mr. M. G. Howe, the Engineer of Maintenance of Way, showed that about 70% still remained in the track and were perfectly sound. The removal from time to time has been necessitated on account of rail cutting and spike wearing. In July, 1880, there were placed on the Houston prairie some 3,000 ties of the same material, and, by actual count in August, 1897, there still remained 2,147, which were perfectly sound, but many of them have been turned over on account of abrasion by the rail. Most of these ties are still in the track, and are now protected by tie-plates. It may be noted that the practice on this road is to fill in the gravel ballast nearly to the underside of the rail head, completely burying the ties.

THE MANHATTAN ELEVATED R. R. CO., on June 12, finally decided to adopt the third-rail system of distribution of electric power, and the double-end system of propulsion, with a motor car with two motors each at each end of a 6-car train. Work on the central power station has been commenced, at 74th St. and East River, and the erection of the iron work will begin on July 1. The machinery for the power station has been contracted for with the Allis Engine Co., of Milwaukee, for over $3,000,000, and it will commence to arrive in September. The power house will be 425 ft. long by 200 ft. wide. An electric elevating stairway is to be erected at 59th St. and 3d Ave., and one of another type at 23d St. and 6th Ave.; these are experiments to see which is best suited to the demands of traffic.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head-on collision of a local freight and a gravel train near Ontario, O., on the Erie R. R., on June 14. The two trains were badly wrecked and two persons were killed. A runaway logging train on the Oregon & Texas R. R. (logging) on June 15 was derailed and wrecked. Seven persons were killed and a number of others injured by jumping from the runaway cars and in the wreck.

EXTENSIVE SANITARY IMPROVEMENTS at New Orleans are now under consideration by the new sewerage and water board. A few days ago the board received an interesting preliminary report from its advisory board of engineers. The latter body is composed as follows: B. M. Harrod, Past-Prest. Am. Soc. C. E., Chairman; Rudolf Hering, M. Am. Soc. C. E.; L. W. Brown; Geo. W. Fuller, Assoc. M. Am. Soc. C. E.; Thos. L. Raymond, M. Am. Soc. C. E.; and A. C. Bell. The majority of the board are residents of New Orleans, and Messrs. Hering and Fuller are from New York. Mr. F. S. Shields is secretary of the advisory board and Mr. Geo. G. Earl, M. Am. Soc. C. E., is general superintendent of the sewerage and water board. The advisory board, in its preliminary report, recommends a number of lines of action, chiefly in the direction of investigations to secure data necessary for designing the proposed improvements. The first of these recommendations was to the effect that the general superintendent "be authorized to make a survey of the obstructions to sewage and water pipes now located in streets of the city." Other recommendations were that the general superintendent be authorized to ascertain the value of the physical property of the New Orleans and the Algiers Water-Works Cos., and of the New Orleans Sewer Co., the probable cost of an artesian well not less than 12 ins. in diameter and 3,000 ft. in depth, and the possibilities of other river sources of water supply than the Mississippi River. A portion of the report is devoted to a consideration of the feasibility and best methods of purifying water from the Mississippi River. The advisory board believes that the amount and fineness of the suspended matter in this water renders "it more difficult to purify than the water supply of any other large city in the world." While believing that the river water "can be purified in a thoroughly satisfactory manner, and at a total cost within reasonable limits," the advisory board is of the opinion that investigations covering a year and costing not over $20,000 should be begun at once to determine what plan of treatment is best suited to the waters of the Mississippi River at New Orleans, and recommends "that the general superintendent be authorized to select a competent assistant to serve temporarily as an expert in the immediate supervision of the needed investigations for water purification."

FIVE-YEAR CONTRACTS FOR THE COLLECTION and disposal of garbage, dead animals, night soil, ashes and miscellaneous refuse at Washington, D. C., have just been awarded. Garbage and dead animals will be collected, removed from the city and treated in a reduction plant for $51,000 a year, under a contract awarded to Mr. M. H. Chamberlain, of Detroit, Mich. It is understood that the reduction process employed will be similar to that used at Detroit and used wholly or in part at Columbus and Cleveland, O. (see Eng. News, May 31, 1900, for description of plant at Cleveland). It appears that there is a rebate of 50 cts. per ton for all garbage collected above 20 tons per day, which, it is estimated, will reduce the actual cost of the work to the district. The contracts for the collection and disposal of other wastes were awarded to Mr. R. V. Rusk, of Washington, D. C., as follows: Night soil, $17,000 per annum; ashes, $29,979; miscellaneous, $8,000; making a total of $64,979 for these contracts and $106,579 per annum for these and garbage and dead animals in addition. Mr. Warner Stutler is superintendent of street cleaning.

MEASURES TO PREVENT ELECTROLYSIS are being taken at Newark, N. J., by the North Jersey Street Railway Co. The company has petitioned for an ordinance granting it permission to lay underground conduits for feed and return wires from its power house in two directions, the conduits to be laid in sections during the next three years and to cover the territory enclosed by a circle two miles in diameter with the power house as the center. The connection of the return wires with the rails is proposed. It is understood that all the rail joints in this territory will be cast-welded, and that the company has bought the right to use the Falk apparatus for making these joints on all its lines in Newark, Jersey City and the outlying territory, work already being in progress in portions of Jersey City. The prevention of electrolysis, however, is only incidental to this joint work, its main object being to cut down coal consumption and give a better rail support. A certain half-mile of 24-in. water main in Newark is at present the shortest path for the return current to the street railway power house, and is carrying a large amount of current. The water department hopes that the proposed changes will remove practically all this current. The Newark city ordinance authorizing the change from horse to electric power provides that the city may demand the substitution of the under trolley for the overhead system as soon as the former is proved to be efficient, the question to be decided by three experts, one to be chosen by the city, one by the street railway company and the third by these two. We are indebted for this information to Mr. Morris R. Sherrerd, Engineer and Superintendent of the Newark Water Department.

AN ACT TO REGULATE THE PRACTICE OF ENGINEERING and surveying in Louisiana is before the Legislature of that State. It proposes that the Governor shall appoint two examining boards, one for civil and one for mechanical engineers; these examiners must be recommended by not less than 20 engineers or surveyors of established reputation. After the law goes into effect, any person desiring to practice engineering or surveying in the State must first present himself to this board and pass a satisfactory examination, or have accepted by the examiners a diploma from an engineering school of good standing; though they may disregard this diploma. The applicant must not be less than 21 years old, and be of good moral character. When a certificate is issued it must be recorded in the office of the Clerk of the Civil District Court of the Parish, and this record be endorsed on the certificate. The complete list of registered practitioners shall be published yearly. The examiners would receive $10 per day and expenses during session, and charge a fee of $5 for each certificate and $25 for each examination. The penalty for practicing without a certificate, or for attempting to give evidence as an engineer, is a fine of from $25 to $100 for each offence, or imprisonment of from 30 to 90 days. These certificates may be revoked for cause at any time by a majority of the board.

THE EXPORTS OF THE UNITED STATES, for the fiscal year ending June 30, will exceed those of any previous year by $150,000,000; and its exports of manufactures exceed those of any other year by $75,000,000. The U. S. Bureau of Statistics place the total value of exports for the 11 months of the year at $1,286,214,534; and the June exports should bring this figure up to $1,400,000,000. This would exceed the record year of 1899 by $173,000,000.

NEW DOUBLE 140-FT. SPAN STONE ARCH BRIDGE FOR THE FITCHBURG R. R., AT BELLOWS FALLS, VT.

One of the most notable stone arch railway bridges in America has recently been completed by the Fitchburg R. R. to carry its line across the Connecticut River at Bellows Falls, Vt. This bridge was built to replace a two-span Burr truss wooden bridge which had become inadequate to carry the traffic. Each span of the old bridge consisted of three trusses carrying two railway tracks. As the location selected for the new structure was only a little to one side of the axis of the old bridge, the north truss was removed from each span of the old structure, leaving the two remaining trusses to carry the railway traffic on a single track. With this arrangement the new arch structure extended only 9 ft. under the remaining trusses of the wooden bridge, the keystones clearing the bottoms of these trusses by about 2 ft. The view, Fig. 1, indicates the relative position of the old and new structures for one span quite clearly. It will be observed that the locality presents two very representative examples of wooden bridge construction. Fig. 2 gives a view of the completed stone structure just built.

FIG. 1.—VIEW OF SITE OF DOUBLE 140-FT. SPAN STONE ARCH BRIDGE, SHOWING EXISTING WOODEN RAILWAY AND HIGHWAY BRIDGES.

Turning to a consideration of the new structure, it may be noted first that the railway line crosses the river at the falls 80 ft. above the bed of the river, where it is practically impossible to maintain falsework except at extreme low water. Owing to the high price of structural steel and the long time which would necessarily elapse before completed trusses could be delivered at the site of the bridge, it was immediately decided to erect masonry arches, the location of the bridge being particularly favorable for such construction. Work was commenced on the foundation on Sept. 12, 1899, and trains were running over the completed bridge on Dec. 10, 1899, ninety days after. It happened that the river was extremely low during all the time the work was going on, and it was without doubt the only time for several years when dry weather had continued for so long a period.

The bridge consists of two arches, each of 140 ft. span and 20 ft. rise, constructed as shown by Fig. 3. The arches abut against a natural pier of granite ledge in the middle of the river, on which the pier of the old bridge was founded. The arches are 27 ft. wide, the double courses of coping stones being offset 6 ins. in each course, making the bridge 29 ft. wide at the track grade. Each ring contains 72 courses 4 ft. thick.

The very narrow gorge through which the river ran at the low stage of water encountered during the construction, permitted the erection of falsework bents generally 16 ft. apart to carry the centers proper, all the posts forming bents being 14 × 16-in. hard pine, and were placed on the solid ledge, the latter being cut out to give a perfect bearing. Holes for 1½-in. dowels were drilled into these bearings and posts fitted down into them. To span the gorge required a length of 38 ft. and inclined bents were built with specially-prepared foundation of concrete on the solid ledge, the whole length of sills, to hold up centers over the waterway. Centers proper were built of 10 × 12-in. spruce for posts, and on top of them, to form circle, were spiked four thicknesses of 3-in. spruce plank laid to break joint, the bottom joints being on short bolsters. There were no mortices, tenons or bolts in the entire structure, spikes and drift bolts being used in all cases.

By the use of a plank circle the entire area of posts was available to carry the load which on center posts was about 30 tons. On account of the inclined bents, and irregular lengths of posts, it was thought best to put the wedges directly under the lagging, on the plank circle, one pair under each lagging at each bearing, of which latter there were six. There were six centers under each arch, spaced 5 ft c. to c., and lagging was 8 × 8 ins., 2 ft. on centers, so making 432 pairs of wedges under each arch. The wedges were of oak, 6 ins. wide and 18 ins. long, with a "drive" of 2 ins. With the weight distributed in this way it was difficult to free the wedges after work was done, due probably to the fact that wedges were of green timber and not planed. These centers settled together only 1 in., and developed no weaknesses in any way. Their construction is shown quite clearly by Figs. 1 and 3, and also by Figs. 4 and 5.

The intrados of the arch stones was [illegible] dressed and to allow for rock faces the cent[illegible] were built 4 ins. slack, and to calk the bottom [illegible]ots, pieces of scantling 1 × 4 ins. with a V-edg[illegible]re tacked to the blocks which held the sheeti[illegible] in position and in addition joints were also cal[illegible] with rope yarn. The voussoirs were cut to a [illegible] joint on the intrados, and were left open 2 i[illegible] on the extrados. Each joint was thorough[illegible]filled with Portland cement mortar, which was [illegible]ped with strips of ½-in iron 3 ins. wide, so that [illegible] the space between the stones was completely fi[illegible]

The centers were kept in position [illegible] a month on the west arch, and for three week[illegible] the east arch, and when they were struck [illegible] was no settlement of the arches which could [illegible]easured nor could any cracks be found any[illegible]re in the masonry. A settlement of 3 ins. ha[illegible]een provided for in the centers, and 1 in. [illegible] this was taken up by the settling together o[illegible]e timber before the arches were closed, so th[illegible] the intrados of the arches at the keystone is [illegible]ay 2 ins. high.

The arch sheeting was laid under th[illegible]d bridge with snatch blocks hung to the floor [illegible]ams, the hitch being changed for each stone. N[illegible]withstanding this difficulty the entire ring of the east arch containing 600 cu. yds. of masonry was laid in four days. When the backing was in place a trestle was built over the arches clearing the old bridge, and trains were immediately transferred to the trestle.

The quantities comprised in the arch masonry and centering were as follows:

Ring stones and skewbacks	1,252 cu. yds.
Coping	286 " "
Rubble	2,407 " "
Concrete in foundation	180 " "
Timber in centers	232 M. ft.

The plans for the new bridge were prepared in the Engineer's office of the Fitchburg R. R., under the direction of Mr. A. S. Cheever, Chief Engineer, and the masonry was constructed by Holbrook, Cabot & Daly, of Boston, under the personal supervision of Mr. J. W. Rollins, Jr., of that firm. We are indebted to Mr. Cheever for the matter from which this description has been prepared.

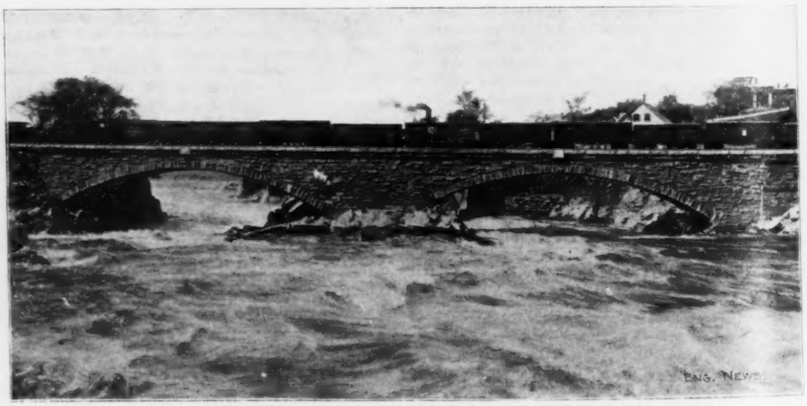


FIG. 2.—VIEW OF DOUBLE 140-FT. SPAN STONE ARCH BRIDGE FOR FITCHBURG R. R., AT BELLOWS FALLS, VT.
A. S. Cheever, Chief Engineer, Fitchburg R. R.
Holbrook, Cabot & Daly, Boston, Mass., Contractors.

METHODS AND RESULTS OF SURVEYS AND BORINGS FOR OSWEGO-MOHAWK SHIP CANAL ROUTE.

By D. J. Howell.*

I.

Under Act of Congress of 1897, the U. S. Board of Engineers on Deep Waterways was created composed of Lieut.-Colonel Chas. W. [illegible]aymond, Corps of Engineers, U. S. A.; Mr. Geo. [illegible] Wisner, M. Am. Soc. C. E., of Detroit; and [illegible] Alfred Noble, M. Am. Soc. C. E., of Chicago. [illegible]mong the routes authorized to be investigated an[illegible] reported upon by this board for a ship canal, of d[illegible]hs of 30 and 21 ft, respectively, was that kno[illegible] as the Oswego-Oneida-Mohawk route, extend[illegible]g from the Hudson River, near Troy, N. Y., v[illegible] the Mo-

*State of New York Canal Survey, Albany, [illegible] Y.

hawk V... Oneida Lake, to Lake Ontario. The au... ngaged as Assistant Engineer in cha... nvestigations of the Eastern Di- vision ... te, some 90 miles in length, and it is to t... this division that this article re- fers. ...iformity in methods was ordered on al...

Th... "General Instructions to Field Parties"† were adopted and issued by the U. S. Board of Engineers to the Assistant Engineers in charge of each division:

General Instructions to Field Parties.

The following instructions are for the general guidance of field parties and will be supplemented from time to time by special instructions from the Board as may be found necessary.

The immediate object of the work is to obtain data for the development of plans, estimation of costs, and the construction of maps and profiles of the proposed ship canal from the Great Lakes to the Atlantic.

Considerable discretion will be allowed chiefs of parties as to methods by which information shall be obtained, and the distribution of work among members of the parties, but the records of all surveys and examinations must be so full and complete that they may be easily and correctly interpreted by computers in the office of the Board without assistance from the engineers who make the observations.

The work must be such that when reduced and plotted, a paper location may be made of the proposed ship canal, a correct estimate made of the amount and kind of material which will need to be excavated, and the size and character of all necessary structures projected.

Organization.

The ... personnel of the parties herein outlined is based on normal conditions of country, a full-sized field party consisting of a base-line party, level party, sounding party (where needed), two or three boring parties, three stadia parties, with draftsmen and computors sufficient to keep up reduction and plotting of field notes as close as practicable with the field work. All parties are to work with the general purpose in view that the combined results of the different divisions should be sufficient to furnish the necessary data on which to base designs, plans and estimates of proposed ship canal route; and, in order that the best progress for amount of work done shall be obtained, it is essential that the parties should not duplicate their own work or that of others, except where necessary for correcting errors.

Each of the stadia parties should consist of 1 instrumentmen, 1 recorder, 2 rodmen, and 1 stadiaman, for open country, and such axemen as may be needed to cut lines where topography of wooded country is to be determined. In organizing new parties, recorders and rodmen, where capable, should always be promoted in preference to appointing new men.

Methods of Work.

Reconnoissance.—A careful reconnoissance should be made of the proposed line of survey, by the assistant engineer in charge, in advance of all field work, to determine the limits of survey, and the probable location of right-of-way, along which it will be necessary to determine contours carefully, and make borings sufficient to establish the elevation of rock surface where it exists within limits of probable depth of cut

Topography.—The topography will be based on continuous transit and level lines between terminals of any section of the proposed canal, and be determined by stadia readings from the stations and bench marks of said lines to all characteristic points.

Topography will be taken with the view of correctly plotting contours for 2 ft. intervals, along right-of-ways, but, outside of such limit, slight irregularities of the surface are of no importance, and only elevations of characteristic points should be taken by the stadiamen, and sketches made between.

Base line and level observations, where possible, should be kept in the advance of topographical work, and the elevations and location of transit stations, with azimuth of line, furnished to the stadia parties.

Transit Lines.—the distances between transit points of main line should be measured with a steel tape of which the length has been determined by actual measurement of a base line of known length, or by comparison with some standard measure already determined, and such distances checked by intersections on known points or by stadia readings of the topographical parties.

The true azimuth of the survey line should be determined at intervals of about five miles along the route, by observations on elongation of Polaris, for the purpose of correcting the transit line for errors of observation and for change in azimuth due to convergence of meridians. To determine the azimuth of a line from observations of Polaris at elongation, a set of readings should be made between the star and reference mark, and the telescope should then be reversed and a second set made.

The difference between the observed azimuth, at any station and that brought forward from previous station by transit line, is always equal to the algebraic sum of the errors of observations and the change due to the convergence of meridians. The latter of these two corrections should be distributed back through the transit stations proportionally to the respective westings, and the former proportionally to the number of transit stations between azimuth stations. In order, therefore, that all corrections be properly applied, there should be an azimuth determination of transit line in advance of all work plotted on office map.

Permanent marks as reference points will be established by the transit and level parties at frequent intervals along the line, such that any paper location made upon the maps may be easily and correctly staked out on the ground surveyed.

Levels.—The elevations of all bench marks of level lines will be based, wherever possible, on the elevation of bench marks established by precise level parties of the U. S. Lake Survey, and unless checked by readings on points of known elevations, should be determined by duplicate lines run in opposite directions.

Duplicate level lines must agree within the amount shown by the formula

$$\frac{5}{100}\sqrt{\text{distance between bench marks in miles.}}$$

Frequent readings should be made for connecting with the water surfaces, wherever the lines run are in the immediate vicinity of lakes, rivers, or canals.

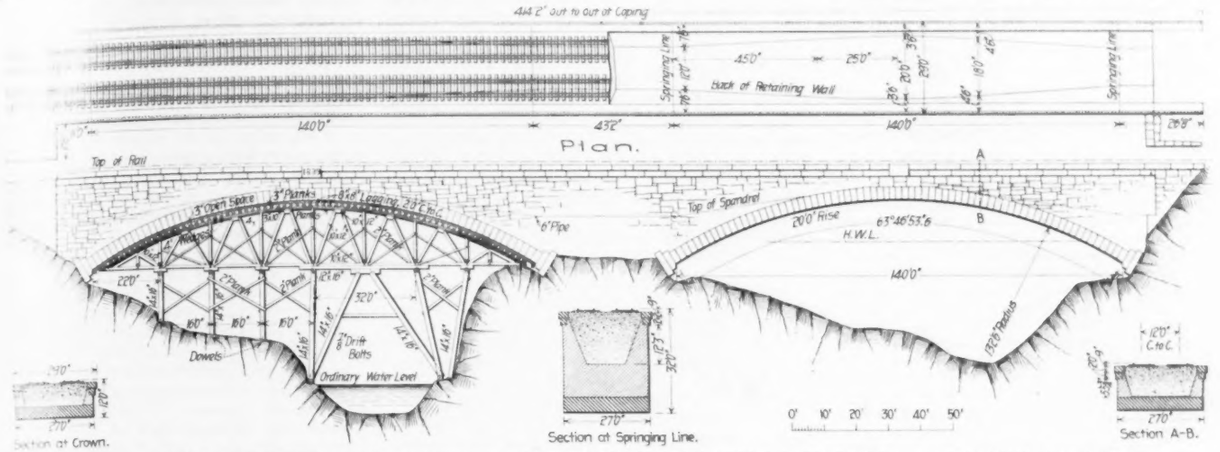
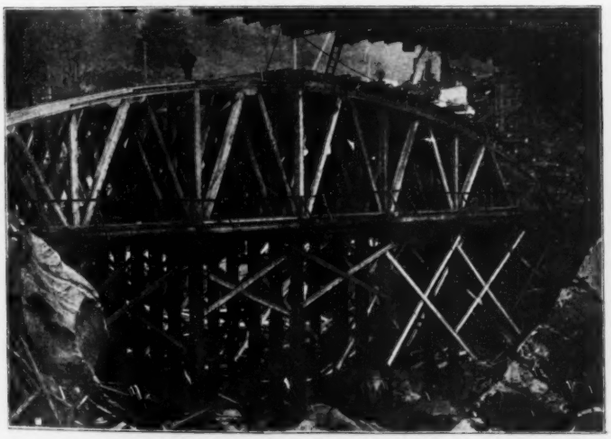


FIG. 3.—PLAN, ELEVATION AND SECTIONS OF DOUBLE 140-FT. SPAN STONE ARCH BRIDGE AT BELLOWS FALLS, VT.



FIGS. 4 AND 5.—VIEWS SHOWING FALSEWORK CENTERS FOR DOUBLE 140-SPAN STONE ARCHBRIDGE AT BELLOWS FALLS, VT.

†As presented by Mr. Geo. Y. Wisner, M. Am. Soc. C. E.

Methods of Stadia Work.—Stadia parties should be furnished with corrected azimuths of transit lines, and all stadia circuits should be carried forward from such initial directions and checked on other lines of known azimuth wherever possible. Where this cannot be done, the magnetic azimuth of lines should be read occasionally, and readings made to prominent points on the line of survey, the location of which may be independently determined. In stadia circuits, stakes need to set only at instrument stations, and at points where side lines are to be started or closures made with other circuits.

Where areas of timber land and orchards interfere with lines of sight, contours may be developed sufficiently well by determining cross profiles at intervals by stadia readings along compass line.

No matter which member of the party may make the observations, it should be distinctly understood that he should make the complete readings, both as to direction and distance, and no other person be allowed near the instrument.

The instrumentman and recorder should make the observations, keep the records and make sketches, except where the conditions are such that only two rodmen are needed, in which case the extra rodman may be detailed to sketch or make reconnoissance for advance work.

In addition to readings to develop contours, all buildings, fences, roads, creeks, culverts, bridges, timber lands, etc., should be located, and, where structures are on line of probable final location, the dimensions and character should be noted. Highways, fences, railroads, streams and embankments should be located by readings to points where directions change, and a sketch made showing connection between consecutive points. Where rivers are to be sounded, all range stakes should be set in advance by either the transit or stadia field parties.

The width, depth and cross section of streams for high, low and medium stages should be determined wherever possible. The limit of work for survey should be determined by reducing side shots in the field, and not by running special circuits along line of elevation required.

The instrumentman should have a system of signals for his party such that he may direct a rodman in any direction, and to make any kind of location desired.

In all cases, the work should be so planned that stations need not be reoccupied, except to start new lines or to correct errors, and that work done by other divisions of the main party will not be duplicated.

Where possible to do so, the stadia party should leave stakes for boring party to connect with when holes are drilled, and thus save labor of locating holes after work is done. Stadia parties, in the field, need do only sufficient plotting to insure that records are free from error, and that sufficient locations have been made to develop the topography.

Borings.—Borings will be made at such intervals and depths along the lines that the location, amount and kind of material to be excavated may be accurately estimated for a ship canal of 30 ft. depth located within limits of strip surveyed.

Reduction of Notes.—The field party should keep their notes reduced up to date, and ready for checking by the computers in office of engineer in charge. All notes, records, and sketches should be so clear and complete that no misinterpretation can occur.

Plotting of Field Notes.—In the office of assistant engineer in charge of party, there should be a draftsman and sufficient computers to reduce and plot the field notes as fast as sent in by the stadia parties.

The computers should be men capable of reducing field notes, and assisting the draftsman in plotting preliminary lines and circuits on maps. Maps should be on a scale of 1-2,500 or 1-5,000, depending on the flatness of the country, and should be mounted on paper 28×40.5 ins. in size, with working limits of 25×37 ins, and laid out so as to have a wide margin at left hand end of completed map. All lines, fences, roads, etc., should be plotted with India ink and all contours with burnt sienna.

Transit lines and important stadia circuits should be plotted by co-ordinates, and side lines and readings by direction and distance. For small vertical angles, no reduction for distance is necessary for side shots, and, for main circuits, the correction may be taken direct from a table prepared for that purpose. Transit line distances should be corrected for tape error and temperature before plotting.

Only such lettering need be put on maps as necessary for a correct interpretation, and no azimuth of courses, except line indicating the true meridian through some azimuth or transit station. All work to be plain and accurate, and of a style to be rapidly done.

Finishing Field Sheets and Reduction.—The finishing of field maps not provided for in these instructions, and the reduction for publication, will be done at the office in Detroit.

All maps for publication are to be reduced to a scale of 1:20,000 by means of a pantograph, such reduced sheets to show the amount of detail to be put on tracings, except that swamp and timber areas will be indicated with topographical symbols; and, where slopes are steep, hachures will be used instead of contours. Where wood and swamp areas are large, only the limits need be indicated by symbols. The line of proposed waterway will be indicated by two parallel lines spaced 250 ft. apart, except in open rivers and lakes, where actual width estimated will be shown.

Location and depth of borings will be indicated by showing elevation of bottom of hole, and, if rock was found, such number will be followed by the letter R.

The projected line will be marked every 1,000 ft. and at every mile on the map, and a profile of the line marked to correspond with that on map will be placed at bottom of the sheet.

Reports.—A weekly report should be made at the end of each calendar week, giving briefly the amount of work done, and any other information of interest or importance. A monthly report should be made promptly at the close of each month, giving a detailed statement of work done, condition of work or works in progress at that date, and other important information or suggestions.

Existing conditions encountered during the progress of the work caused at times a modification of the details of these instructions. The purpose of this article is to give a general outline of the methods pursued and means employed in obtaining the information required, with, as far as possible, the results obtained and the cost of the same.

Conditions.

As existing conditions so largely influence the adoption of certain methods in the work of surveys and borings, and so materially affects its cost, it is deemed of interest in connection with this article to touch briefly on the physical and artificial features along the line of survey.

The area within which surveys and borings were made embraced the Valley of the Mohawk River from its entrance into the Hudson River west to Herkimer, N. Y., a distance of some 90 miles; also, some 40 miles of cross country lines between the Mohawk and the Hudson rivers.

The Mohawk Valley is from one-half to three-quarters of a mile in width, generally level, and for the most part free from woods and underbrush, except the river banks, which in places are lined with a thick growth of bushes.

These banks for a distance of some 15 miles at the lower end of the valley are for the most part perpendicular shale cliffs from 20 to 50 ft. in height; for the remainder of the distance the bottom land is from 5 to 20 ft. above the river. The Mohawk varies in width from 300 to 1,000 ft., with ferries and bridges, for the most part at long intervals, making access from one side to the other, except by row boat, difficult.

The four-track New York Central & Hudson River R. R. follows along the north side of the valley for the most of the distance, and the Erie Canal and West Shore R. R. along the south side. The conditions existing practically divided the area to be mapped, so far as ease of access was concerned, into three strips; namely, that to the south of the Erie Canal, that between the canal and the Mohawk River, and that to the north of the river.

A large amount of detail was necessary to be taken at the numerous cities and villages along the banks of the river to indicate the character and value of the improvements as affecting a canal location. The valley being generally in an improved state of cultivation, liberty of access during the season of growing crops, to the area to be surveyed and upon which borings were to be made, was in a measure restricted, and attended with difficulties.

The cross country lines surveyed and upon which borings were made, were, for the most part, through well-cultivated, rolling farming lands, generally free from large bodies of timber and undergrowth. Where the line of survey followed water courses the difficulties were increased by precipitous banks, wooded areas, and access to the area on each side where the stream was too wide or deep to wade.

The surveys and borings were carried on continuously through the winter months, at times during deep snows. This fact, together with the thawing of the ground in the early spring, and the maturing crops in the summer and fall, all contributed to a greater or less degree to delay the prosecution of the field work of surveys and the moving of the boring machines from place to place.

Transit Work.

A transit party as organized consisted of one instrumentman, one recorder, two tapemen and one axeman. The instrumentman made the observations and had charge of the party; recorder recorded the notes and made sket to enable the future identification of the lin and the finding of the transit points; th tapemen made the measurements, and the a carried and drove the stakes and did any c needed. In wooded sections, or when occasi required an additional axeman was employed. hen permanent transit points could not be conveniently located, oak staves, 2 ins. square, driven flush with the ground at intervals about 1,000 ft., with a guard stake driven by time at a fixed distance, when practicable, and measurements taken to fixed objects near by enable the easy finding of the hub. No intermediate stakes were set, except in the case of cross country lines when stakes were generally driven at 400 ft. intervals.

The main object of this transit line being as a base line for the control and use of the stadia work, stakes were driven at locations advantageously situated for the stadia parties to occupy the same and sweep as large an area as possible or to tie in stadia circuits run. Stone monuments were set or permanent points selected at intervals of five or six miles along the transit line, generally where observations for azimuth corrections were made. On days unfit for field work, this party was engaged in the computation of corrected azimuths and the co-ordinates of transit stations.

These, with sketches from the note books and tie measurements to all transit points to facilitate the easy finding of the same by the stadia parties were promptly made out with duplicate carbon copy and sent in to the office of the Assistant Engineer. The co-ordinates were carried continuously through the entire work from its origin to its termination. The error as found between the observed azimuth at any station and that brought forward from a previous station, which we will term the "running" error, ranged, after the corrections for convergence of meridians was applied, from 00′ 35″ to 06′ 20″, and the distance between azimuth observations taken ranged from 5.7 to 9.6 miles.

The average for 14 observations was, "running error," 02′ 30″, distance 6.3 miles. A transit line traverse of 9.2 miles, the general direction of which was north and south, gave a "running error" of 01′ 30″, and an error in latitude of 0.15 and in departure of 0.59 ft. This traverse was over very favorable ground for measurement, and the sights were reasonably long. Another transit line traverse of about 3½ miles showed an error in azimuth of 02′, and in latitude of 3.75, and in departure of 3.82 ft. The above are the only cases in which the transit work closed back upon itself, affording a check in closure as above stated.

At the beginning of the survey, at the crossing of the Congress St. Bridge over the Hudson River at Troy, N. Y., a tie was made between station 0.0 of the transit line, and a N. Y. State triangulation station near there. Connections were also made between the transit line and N. Y. State triangulation stations at Amsterdam, Canajoharie, Little Falls and Herkimer, the last-named being at the end of the work of this division.

Table I. will show the comparison between the transit work and that of the N. Y. State Triangulation. The proportion of error to distance as given in the table is found by obtaining the hypothenuse of a right-angled triangle, the latitude and longitude representing the base and height, respectively, divided into the total distance and expressed as a fraction.

TABLE I.—Showing Comparison Between the Transit Line Distance and the N. Y. State Triangulation Stations.

	From Congress St. Bridge to—	
	Amsterdam.	Herkimer.
Distance in miles by transit line....	40.5	89.4
Difference in lat.,* N.Y. State survey	74.809	107.852
In long.,* N. Y. State survey....	131.361	345.965
Difference bet. transit line and N. Y. State survey, in feet: Latitude..	24	46
Longitude	99	99
Proportion of difference to distance..	1 / 5,632	1 / 10,255

*Expressed in feet.

Level Work.

The level party consisted of the same force as the transit party, the tapemen acting as level rodmen, and the axeman either as umbrella holder

assigned him. The recorder ... checked ... the target readings as noted ... in his book and, also, the calculations for elevation of turning points ... instrument. The one party was able ... work and duplicate levels in advance of the two stadia parties. While ... as established in "General Instructions ... Parties," as issued by the U. S. Board of Engineers, was 0.05 $\sqrt{\text{distance}}$ in miles, ... was believed, without resorting to precise methods, by the exercise of perhaps a little more care, and with a good instrument and level rod in the hands of a careful instrument-

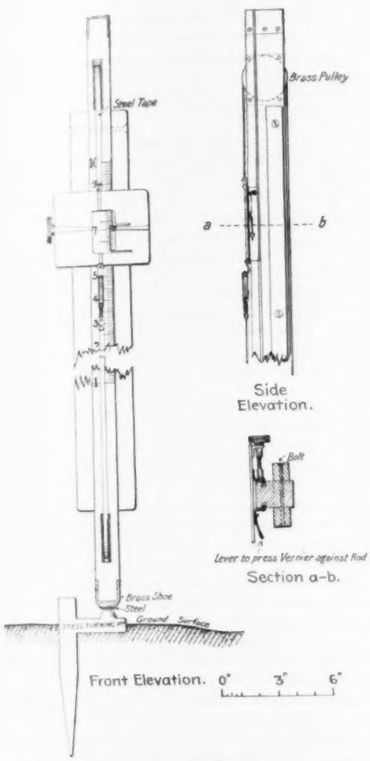


Fig. 1.—Details of Level Rod and Steel Turning Pin; Oswego-Mohawk Ship Canal Survey.

man, results considerably within the limit of error as fixed could be obtained and the extra labor was deemed justifiable in a work of this importance.

On the first 20 miles of levels run at the eastern end of this division, the ordinary Philadelphia level rods were used, and the author is convinced from his experience in this instance and in several others, that for accurate results on lines of any length, and to obtain value received for the labor and care expended at the instrument, the rod used should not be an extension rod, and it must of necessity be accurately graduated. The rods above mentioned were discarded in the early stages of the work, and two rods made to order by Messrs. Gurley Bros., of Troy, N. Y., were used. These rods, which in general design were similar to those used by the U. S. Geological Survey, were made of white pine, parafined about ¼-in. (a greater depth will tend to destroy their usefulness), in one length of 10 ft. 7¾ ins. over all, reading to 10 ft. They were graduated on the face to feet, tenths,, and hundredths with vernier reading to thousandths. On the back of each rod a round, folding plumbing level was attached.

The target was square, 4 ins. in height × 5½ ins. wide, with black enamel face, with a vertical white enamel strip ¼-in. wide through the center and two narrow horizontal white enamel strips tapering from a width of ¼-in. at the outside to 1-16-in. at the center. This strip offered an excellent background for the accurate setting of the target by the cross hair in the level. The target was moved up and down by a steel tape ¼-in. in width, attached to the top and bottom of the target by tension screws, and passing over small pulleys set flush in the rod near the top and bottom.

The target vernier was arranged so it could be pressed down flat on the face of the rod by a spring, thus enabling more accurate reading. The price of these rods was $25 each, including a heavy canvas cover in which they were always carried, except when in actual use. Fig. 1 shows a front, side view and section of the rod, also the steel pins used for turning points. These pins were driven firmly in the ground with a wooden maul.

The advantages of the rods and turning points used are, briefly stated, less liability of the rod to change of length through influences of moisture; no risk of the rod slipping, as in the use of a sliding rod; exact graduation; no risk from the rod being held at a different elevation on the turning point selected, for fore and back sight, and the target arrangement enabling a more accurate setting and reading of the same. All of the above points are essential to obtaining good results.

Duplicate levels were run in opposite directions and the instrument shaded from the sun's rays in hot weather. Two rodmen being used, the forward sight on the next turning point was immediately taken after the back sight, thus avoiding the risk of the instrument settling, which was an important consideration, as the work was carried on during not only extremely cold weather, with heavy snows at times, but also during the spring thaw and summer heat. Work was not attempted during high wind, as several attempts to do this invariably resulted in defective work and a greater error than otherwise between duplicate lines. Bench marks were established at intervals of from one to one and one-half miles. The mean elevation of the two lines run in opposite directions was adopted as the elevation of the bench mark.

The maximum value obtained for the 0.05, which decimal will be referred to as "C," in the formula for limit of error, was between consecutive B. M.'s 0.035 for 1.66 miles, the minimum 0.001 for 0.93 miles, and the average value of "C" for sixty-eight bench marks in a distance of 88 miles was 0.0115. The maximum value of "C" for lines from the origin was .022 for 18.29 miles, the minimum 0.001 for 5.86 miles, the average being 0.009 for the 88 miles. The following values of "C" were obtained at distances stated from the origin, these values being selected at random:

0.018 at 20.81 miles.	0.004 at 60.96 miles.
0.003 at 39.53 miles.	0.002 at 87.86 miles.

A Buff & Berger level No. 2652 was used on the work. It is but just to say that this line of levels was run for three-fourths of its length over for the most part, level stretches, following the transit line along railways, roads and the Erie Canal tow path. The total difference in level between the origin and the end of the line was about 367 ft.

(To be concluded.)

2,500-HP. TRIPLE EXPANSION ENGINE AND DIRECT-CONNECTED ALTERNATOR AT THE PARIS EXPOSITION.

(With two-page plate.)

We illustrate in the accompanying cuts and on our two-page plate this week the general details of the 2,500-HP. triple expansion engine and direct-connected alternator installed at the Paris Exposition to provide current for lighting the buildings on the Champ de Mars. The drawings are reproduced from our German contemporary, the "Zeitschrift des Vereines Deutscher Ingenieure," from which we also abstract the following description of the installation.

Triple Expansion Engine.

This engine is of the vertical tandem type, with double low-pressure cylinders. The cranks are 180° apart. The high-pressure cylinder is 30 ins. in diameter; the intermediate cylinder is 46½ ins. in diameter, the two low-pressure cylinders are 52¾ ins. in diameter, and the stroke is 47¼ ins. At the normal speed of 90 revolutions per minute, with 210 lbs. steam pressure (about 20 expansions), and running condensing, the engine delivers 2,500 HP. At the Exposition the engine will serve to drive the Siemens-Halske alternator described below.

The crank shaft is in two parts, and at one end is provided with a crank disk, which drives two vertical, single-acting air pumps, which are bolted together and mounted in a pit 8 ft. 2½ ins. below the engine floor. The other end of the crank shaft is coupled to the dynamo shaft. The latter rests in two massive self-oiling bearings, movable upon the foundation, and carries between these bearings the revolving field of the dynamo, and at the outer end the exciter armature.

The bed plate of the engine is formed of two parts, united by flanges and bolts. Each half supports two crank shaft bearings, and between these

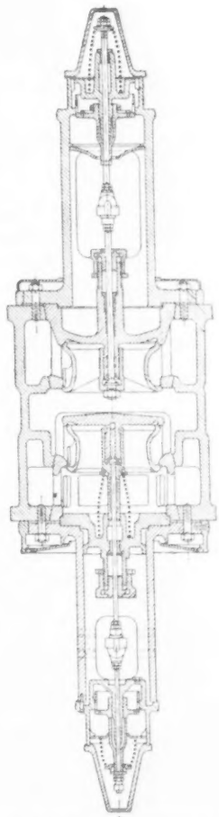


Fig. 4.—Vertical Section of Poppet Cylinder Valves, 2,500-HP. Engine for Paris Exposition.

is hollowed out to catch the waste oil. Two small pumps driven by a spiral gear from the crank shaft force the collected oil to a purifier, from whence it is distributed to the oil cups.

Between the bed plate and the large dynamo bearing is the 41-ton flywheel, which is provided with gear teeth to mesh with an electric motor-driven starting device.

Upon one side of the bed plate are bolted the two massive cast-iron uprights which carry the cross head guides, and upon the other side are two large forged steel columns, which are secured at the bottom in eyes in the bed plate and at the top in similar eyes in the uprights, and which serve to give the engine great stability. Centered upon the upper flanges of the uprights are the two low-pressure cylinders, which are firmly bolted together. Upon these stand cast-iron supports, which are stiffened by wrought-iron columns bolted in on the open sides. The high-pressure and intermediate cylinders are carried by these supports. On all the cylinders the stuffing boxes are set in, and the cylinders are provided with steam jackets, which are heated by the working steam of the cylinder. The high-pressure piston is provided with cast-iron Ramsbottom expanding rings and the other pistons with Buckley rings of the latest type. All the pistons are of cast steel.

The supports between the lower and upper cylinders are so formed that, when the wrought-iron columns in the side openings are removed, the upper cylinder heads and pistons of the low-pressure cylinders can be taken out. After uncoupling from the cross head the piston rod can be dropped through a hole in the bed plate, usually protected by a cover, into a cavity provided in the foundations, from which it may be drawn out past the top of the upright.

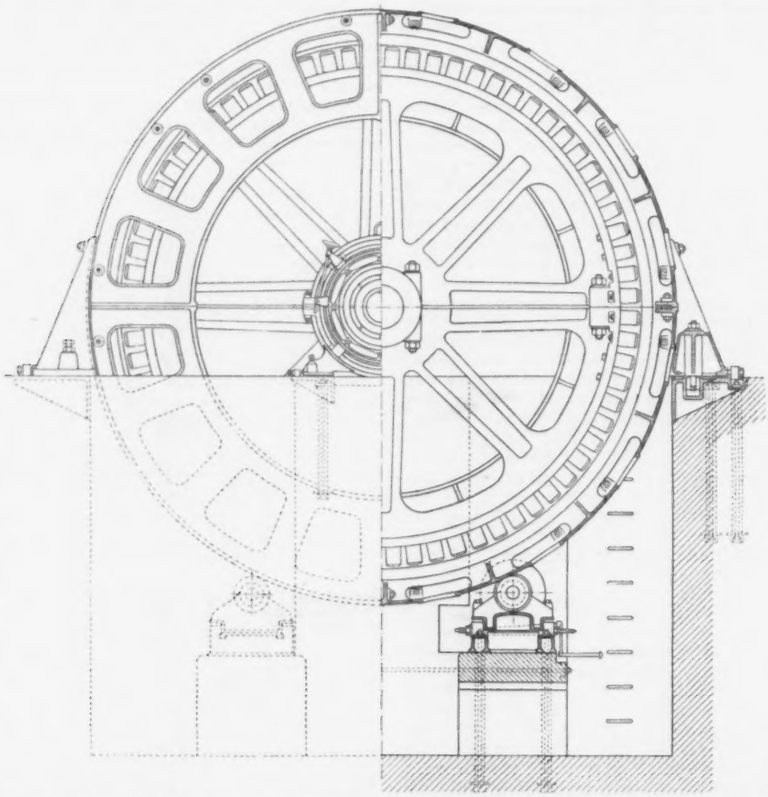


FIG. 5.—SIDE ELEVATION OF SIEMENS-HALSKE ALTERNATOR, DIRECT-CONNECTED TO 2,500-HP. ENGINE.

All the cylinders are provided with double-seated valves having oil dash pots after Collman's patent (Fig. 4). They are contained in extensions of the cylinder castings, in the rear of the high-pressure and intermediate cylinders, and at the sides of the low-pressure cylinders. The valve gears are operated by eccentrics placed upon a shaft resting on six brackets at the rear of the low-pressure cylinders. Motion is taken from the crank shaft by bevel gears, and an idle shaft rising obliquely between the uprights and carrying the spring-loaded flyball governor.

The admission and exhaust valves of the four cylinders are operated by a trip release gear; the release of the admission valves of the high-pressure cylinder being controlled by a rod from the governor, and that of all other valves by devices adjustable by hand. The peculiar oil dash pots of the new Collman gear may easily be so adjusted that the closing of the valves is almost noiseless. On the high-pressure and intermediate cylinders a single eccentric operates an admission valve with its accompanying exhaust valve, but each valve of the low-pressure cylinders has its own eccentric. The speed of rotation of the engine may be adjusted while the engine is in motion by a hand-wheel and auxiliary spring attached to the governor housing.

The rotating masses of the connecting rods are balanced by counterweights bolted onto the cranks. The connecting rods and cross heads are of the form adopted in the most recent large marine engines. The piston rods of the two cylinders on each side of the engine are formed of one continuous piece.

At the front of the engine is a platform a few steps high which gives access to the valve gears and the main valves, all being placed within easy reach. Between the steel supporting columns and attached to the edge of the first elevated platform is a large name plate, which bears the different gages and a clock. A bracket on the left column carries a tachometer and a revolution counter.

All stuffing boxes are supplied with oil under pressure. The connecting rods and pillow blocks are supplied from two distributors placed upon the second elevated platform. These receive their oil by gravity from a reservoir placed above them, which is filled by means of a pump from the oil well in the foundation.

The air pumps have valves in the pistons and delivery valves, but no suction valves. The pistons receive their motion from piston rods attached to the two ends of a walking beam, the shaft of which is supported by pedestals standing between the pumps. A crank on the end of the shaft is attached by a connecting rod to the crank disk on the engine shaft before referred to. All bearings and journals of the condenser plant are supplied with oil from a distributor placed on a cast-iron pedestal standing on the floor near the end of the crank shaft.

The live steam is led from the steam main in the rear of the engine to the controlling valve placed between the high-pressure and intermediate cylinders, from which it passes by a short pipe to the front side of the high-pressure cylinder. From this the steam passes by a horizontal copper pipe to the intermediate cylinder and then through a vertical pipe to a cast-iron receiver from which the low-pressure cylinders are supplied. From each of these cylinders an exhaust pipe is led down to the air pumps. The lower ends of these pipes, under the floor, are the injection cocks.

In the design of the engine much care was taken to make all parts as simple as possible in order to secure reliability of operation with little attendance. By means of the galleries arranged in four stages and the steps in the rear, all parts of the engine are readily accessible.

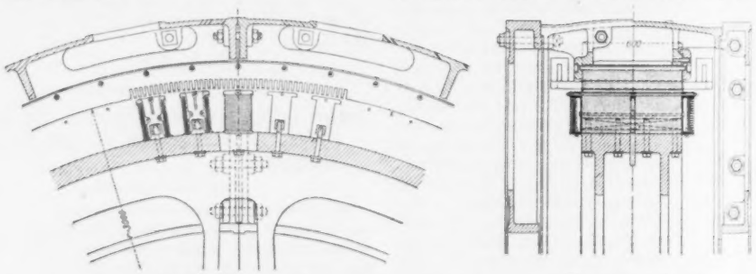
At the Paris Exposition the engine will run at 83.5 revolutions per minute under an initial steam pressure of 140 lbs., and will serve principally for furnishing current for lighting the buildings upon the Champ de Mars.

The Dynamo.

The alternator connected to this engine was designed and built by Siemens & Halske, of Charlottenburg, Germany. It is intended to run at 83.5 revolutions per minute, and to deliver 2,000 K-W. with an inductionless external circuit, and, according to the Exposition specifications, will give 2,000 to 2,200 volts at 50 cycles per second. The engine will, therefore, under the conditions at the Exposition, operate the dynamo to only 70% of its capacity. This ratio was determined upon, as nothing certain could be known beforehand concerning the exact purposes for which the dynamo would be used.

The machine (Figs. 1 to 6) has a rotating field magnet with 64 poles and a stationary armature. The field magnet consists of a two-part cast-iron wheel keyed directly upon an extension of the crank shaft. The poles are built up of laminated iron, which is held together by three bolts on a square steel block. The steel block is tapped out to receive the end of a bolt passed through the cast-iron rim of the magnet frame, and holding the pole in place. To take care of tangential forces there is a rib at the base of the pole piece which fits into a transverse slot on the rim. The winding of the poles consist of copper strips wound edgewise. On both sides this copper is surrounded by hollow castings of bronze, through which the air can flow radially. Through the middle of the rim there is an air passage which allows fresh air to flow constantly into the space between the magnet faces and the armature.

The stationary part of the machine is formed of two rims, of such dimensions that there can be no material bending or change of form. The rims are built up of four parts bolted together, and consists of two concentric rings connected by strong radial spokes.



Longitudinal Section. Transverse Section.

FIG. 6.—DETAILS OF ARMATURE AND FIELD MAGNETS OF ALTERNATOR.

Upon these parallel rims the armature, which consists of four parts, is fastened. In this way the two rims and the armature form a rigid structure. The armature core is built up of iron sheets, ½ mm. thick, held together by cast-iron frames. The exterior of the supporting rims is turned off smooth and rests upon two rollers, which are adjustable in height. By raising or lowering both rollers the center of the structure can be moved vertically, and by raising one and lowering the other it can be moved horizontally, which furnishes a means of center-

ing the ... The rims always rest upon the rollers, ... prevent turning of the armature during ... and to take up whatever forces there ... in the direction of the shaft, there are two ... standards to which the rims are, in addition ... bolted. When these bolts are removed ... structure may be revolved by turning ... rollers.

The ... has a bar winding which is insulated in ... troughs placed in open slots. The field is ... by current from a direct-current machine ... coupled to the shaft of the larger machine ... delivering 45 K-W. at 210 volts. It is of ... ter-pole type, with a cast-iron field magnet ... eight poles. The armature is drum wound, ... the normal output of the machine at 340 revs. ... min. would be 200 K-W.

NOTES FROM THE ENGINEERING SCHOOLS.

Washington University.—The railway terminal station at St. Louis, Mo., known as "Cupples Station," was on May 29, deeded to the University by Mr. Samuel Cupples and Mr. Robert S. Brookings. This gift has a par value of $3,000,000, and will place the University among the most richly-endowed colleges in the country. It will be divided into two equal endowment funds to be named after the donors. This brings the total endowment of the institution up to $3,625,000.

Columbia University.—The arrangements for the summer class in practical mining of the School of Mines, which will be conducted by Prof. Robert Peele, have been completed, and the students will work this year at the mines around Cripple Creek, Colo. Leaving New York city in June, the class will spend five weeks in underground work in the mines. This will be followed by two weeks' work in field geology under Prof. Arthur Hollick, of the Department of Geology, and then a number of visits will be paid to the metallurgical works of the region.

Dartmouth College.—The following are the titles of the graduating thesis submitted by the graduating class of the Thayer School of Civil Engineering at its recent commencement exercises: "Telodynamic Transmission of Power;" "The Central Steam Heating Plant;" "The Gas Engine as a Prime Motor;" "Experiments on the Flow of Water Over Dams to Determine the Most Efficient Section or Profile;" "Timber Dams for Power Development;" "The Steam Engine Past and Present;" "Power: Some Phases of its Development."

University of Michigan.—The following lectures on subjects related to engineering will be given next year in the new Course of Higher Commercial Education: "Physical Geography of North America, Relative to Industry," 18 lectures by Prof. Israel C. Russell, of the University; "Industrial Significance of Deep Waterway Communication;" five lectures by Mr. Lyman E. Cooley, of Chicago, Ill.; "The Commercial Possibilities of the West Indies for the United States;" six lectures by Prof. Robt. T. Hill, of the United States Geological Survey; "Industrial Resources of the United States," 18 lectures by Prof. W. D. Jones, of the University of Wisconsin; "International Division of Labor," 18 lectures by Dr. O. M. W. Sprague, of Harvard University; "Corporation Financiering," five lectures by Mr. Thomas L. Greene, Auditor of the Manhattan Trust Co., of New York; Prof. H. C. Adams, of the University, will offer a new course on the "Administration of Public and Corporate Industries."

During the summer an extensive addition will be built to the Laboratory of Mechanical Engineering.

Purdue University.—On May 28 the Department of Mechanical Engineering formally dedicated the 2,000,000-gallon water-works pumping engine recently presented to the laboratory by the city of La Fayette. This pumping engine was built by the Clapp & Jones Mfg. Co., of Hudson, N. Y., in 1875, and is of the duplex walking-beam type. As installed in the laboratory it will serve as an example of this type of pumping engine, and in addition to its historical value, will furnish a supply of water for hydraulic experiments.

Iowa State College.—The Mechanical Engineering Department has come into possession, through the generosity of the principal eastern railway lines, of a locomotive to be used for experimental and instruction work.

Rensselaer Polytechnic Institute.—The Institute will have a well-equipped electrical laboratory in operation by the beginning of the next school year.

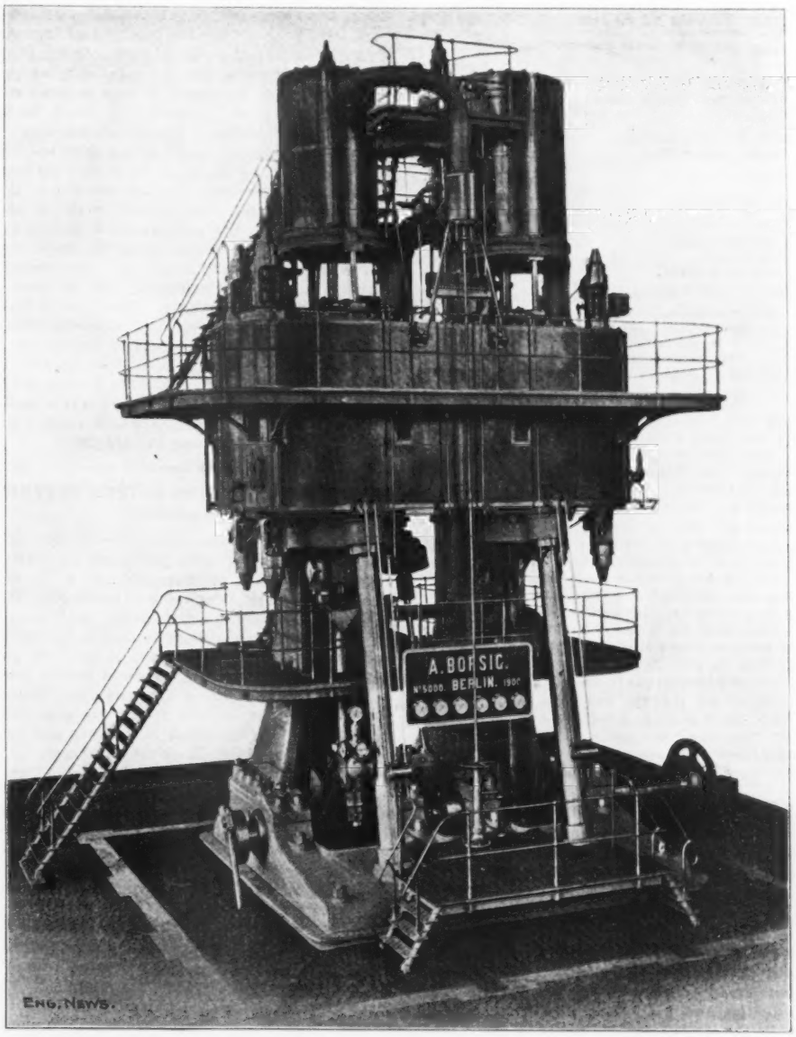


FIG. 7.—2,500-HP. TRIPLE EXPANSION ENGINE OPERATING ELECTRIC LIGHTING ALTERNATOR, PARIS EXPOSITION.

There will also be installed some new testing machines and a new cement-testing laboratory will be equipped.

Massachusetts Institute of Technology.—"Sewage Disposal for Fitchburg, Mass," is the subject chosen for a graduate thesis by one of the students of the Institute. Septic tanks, with subsequent filtration, it is concluded, is the best system for the city. It is estimated that this plan would be more expensive in construction, but more economical in operation, than chemical precipitation, and it is believed to be preferable to intermittent filtration.

THE RAPID DEPOSITION OF COPPER from an electrolyte has hitherto been accompanied with difficulties due to the rough and unequal nature of the deposit thus obtained. Mr. Sherard Cowper-Coles, of England, has recently devised an electrolytic vat, by the use of which a smooth and fine deposit is secured, even when working with the remarkably high current density of 190 amperes per sq. ft. The cylindrical cathode is rapidly rotated, the result being that bubbles or other inpurities are swept off the surface upon which the copper is being deposited. The anode surrounds the cathode and the electrolyte is maintained in circulation between them by pumps. This process allows the use of a hotter and more acid solution, and consequently a lower voltage. At 150° F. only 1 to 1.2 volts are necessary to give the required current density. The copper obtained in this way is suitable for rolling or drawing.

AN ITALIAN AUTOMATIC RIFLE is described in the London "Times." It is the invention of Capt. Cei-Rigotti, and its chief feature is the employment of part of the gas of explosion to eject the empty cartridge-case, reload and fire; continuing this operation until the cartridge clip is empty. A tiny hole is bored through the barrel, near the muzzle; and through this the gas escapes into a passage leading to a rotary cylinder, which is turned by the gas pressure and performs the duties outlined above. Capt. Cei-Rigotti is said to have fired as many as 15 shots per second, with a velocity of 700 m., or almost 2,300 ft. per second, without altering his aim or taking the gun from his shoulder. For slow and deliberate firing an interrupting lever is lowered. The cartridges are supplied in clips of 5 to 25, and it is claimed that the 25 can be automatically discharged in two seconds. The mechanism is said to be simple, and can be easily applied to the Mauser rifle without materially increasing its weight.

THE NEW YORK STATE CANAL SURVEY is well under way. With nine parties in the field, says the Utica "Herald," State Engineer and Surveyor Bond and Mr. D. J. Howell are in charge, under the carefully prepared instructions of the board of consulting engineers, Messrs. George S. Greene, Jr., George Y. Wisner, Edward P. North and Palmer C. Ricketts. Under these instructions a uniform system of work will be insured; all data will be permanently recorded, and means are taken to prevent a repetition of the errors of previous surveys. All surveys and estimates will be made on the basis of a 12-ft. canal on the Erie line; 9 and 12 ft. for the Oswego canal and 7 ft. for the Champlain canal.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - - - VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, - - - TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, — ASSOCIATE EDITORS.

A. B. GILBERT, - - - - - - - ASSISTANT MANAGER.

CHAS. W. REINHARDT, - - - - - CHIEF DRAFTSMAN

ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. B. READ, Boston,
C. F. WALKER, Cleveland, — ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.
LONDON OFFICE, EFFINGHAM HOUSE, 1 ARUNDEL ST., STRAND.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; *6 months,* $2.50; *2 months,* $1.00. *To all other countries in the Postal Union: Regular Edition, One Year,* $7.00 (31 *shillings*); *Thin Paper Edition, One Year,* $6.31 (28 *shillings*). *SINGLE COPIES of any number in current year,* 15 *cents.*

In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 320 *means that subscription is paid to the* 32d *week (that is the issue of Aug.* 9) *of the year* 1900; *the change of these figures is the only receipt, unless one is sent by special request.*

ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page* VXI-XXIII. *New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

It would be hard to name any one thing, so simple and inexpensive in execution, that would contribute more to municipal progress than the paralleling of the work of the Massachusetts Gas & Electric Light Commissioners in the other States of the Union. Besides having a pretty thorough supervision of all gas and electric lighting plants in Massachusetts, particularly as regards their capitalization, and the rates charged for services rendered, the Board brings together year after year a most valuable series of reports on the conditions and operations of the various lighting plants in the State, and also the rates charged for public and private lighting.

As there are 17 cities and towns in Massachusetts owning gas or electric lighting plants, all of which report to the Board, this report furnishes some valuable figures for a comparative study of municipal and private ownership of lighting systems. While exception may be taken to determining the cost of public lighting, in the case of municipal plants, by deducting the gross revenues from the sum of capital charges and operating expenses, yet this at least results in figures of some value for certain comparative purposes. For one thing, it seems to show that in some towns the rates charged private consumers are far too low, and in others far too high, if there is to be any pretence of a proper division of the cost of lighting between the two great classes benefited, namely, private consumers and the municipality as a whole. We have often pointed out the injustice that may prevail where no attempt is made to distribute the expenses of water, sewer and lighting departments between these two classes, or where the attempt is founded on improper principles. To take the case of lighting: If the rates to private consumers are so high as to cover practically the whole cost of lighting public buildings and streets, then the use of gas or electricity for domestic or business purposes is discouraged for the benefit of the taxpayers as a class. On the other hand, if private rates are too low, the taxpayers suffer an undue financial burden, and the chances are that the works will not be maintained at a proper degree of efficiency, or that the streets will be poorly lighted, the latter being particularly true where a fixed price is charged for each street lamp. The Massachusetts commission deserves to be thanked for giving the public such figures as it has regarding the cost of public lighting under municipal ownership, but the manner in which the figures are made up should be kept in mind whenever they are used. It should be noted, in addition, that the ultimate figures in question (cost of street lighting per lamp) do not show the actual amounts raised by taxation, since they all include an item of 5 per cent. for depreciation of plant, while many towns, unfortunately, make no allowance of the sort. The commission would place the public, both within and outside the State, under still greater obligations if it would show the actual expense involved in furnishing light to both private and public consumers. This would involve a distribution of both first cost and operating expenses between the two classes of service, but unless the task, large as it is, is done by some one there can be no certainty that the burden of lighting is properly divided between taxpayers and private consumers; a condition which applies to all lighting plants, regardless of ownership.

THE PROPER MANIPULATION OF TESTS OF CEMENTS; A SYMPOSIUM.

For about two years a special committee of the American Society of Civil Engineers has been engaged in the task of formulating a standard method of manipulating tests of hydraulic cement. Although statements of progress have been received from this committee from time to time, the first actual results of its labors to be made public appear in the form of a progress report printed in the April number of the society's "Proceedings." According to this report the committee's work so far has consisted in sending out extensively a list of about 75 questions bearing on the subject under investigation, and in collating the replies made to them by some 50 members of the society and other persons. The present report, therefore, is merely a symposium of opinion, without conclusions or recommendations of any sort, which are being left presumably for the final report to be made when the committee has entirely completed its work.

Perhaps the most apparent fact which presents itself upon a cursory examination of the replies received by the committee is the evident need of the work which it has set out to accomplish. While there is a fairly close conformity of opinion respecting the proper methods to be pursued in some details of cement testing, the number of different answers to many of the most important questions asked is almost as great as the number of persons who reply to them. This fact, of course, indicates nothing more than was already known, which is that there is a decided lack of uniformity in manipulating tests of cement, nearly every engineer having methods of his own origination, which is the very fault that the work of the committee is hoped to aid in correcting. While it is impossible to bring about a precise agreement between the opinions expressed in the committee's report, yet a moderate amount of integration is possible and develops some instructive facts.

The committee's list of questions assumes at the outset the general proposition that tests should be made of all cement used in engineering work. There is a general agreement in the replies that at least one sample should be tested for every ten barrels of cement used, unless there is reason to be doubtful of the uniformity of the cement when more frequent tests should be made. It is also generally held that the samples to be tested should be taken from the center of the barrels, and should be tested separately. Several of the replies suggest different modes of procedure than those just stated, but there is no agreement among them upon the other methods to be pursued.

In respect to the tests to which it is desirable to submit the samples selected, there are two facts to be noted at the beginning: The replies are restricted by the scope of the questions asked by the committee, and the scope of these questions was limited by the fact that the committee was appointed, not to formulate a set of tests for cement, but only to formulate methods of manipulating the different tests commonly practiced. These tests, as they are conceived by the committee, may be classified for the purpose of discussion as follows: (1) Tests with the dry cement, including; (a) Chemical and Microscopical Tests, (b) Tests for Fineness of Grinding, and (c) Tests for Weight or Specific Gravity. (2) Tests of cement pastes, including; (a) Time of Setting, (b) Soundness, (c) Strength, and (d) Miscellaneous Tests, Adhesion, Abrasion, Resistance to Freezing and Resistance to Action of Sea Water. Summarizing as well as may be the average opinion respecting each of these tests, as it seems to be indicated in the replies made to the committee's questions, we arrive at the following results:

Chemical and Microscopical Tests.—Chemical analyses of cement are quite generally thought to be desirable, but they do not seem to be regarded as by any means essential for the engineer in the field except under special circumstances. In the first examination of a cement, when the physical tests are unsatisfactory, or when a cement is giving trouble, and where certain adulterants are suspected, or where the material is to be used in sea water, chemical analyses are considered useful as giving direct information of value, or as a general indication to the engineer. For the manufacturer analyses are considered necessary to enable him to control the uniformity of his product. Regarding microscopic tests, the general opinion is that they are entirely unnecessary except for a few purposes.

On the whole the replies conform to well-established opinion. Neither chemical analysis nor microscopical examination is practicable to the engineer in the ordinary run of work; they are essentially laboratory tests requiring special training and special apparatus in their manipulation and interpretation. Good cements differ so widely in composition, as was pointed out in our issue of June 7, that no standard based on chemical analyses can well be established except in a few respects. Finally, the whole matter is complicated by the fact that while the analyses will show the composition of the cement analyzed, they do not show how these component parts are combined, and the goodness or badness of the material for structural purposes depends in certain very important respects upon the nature of the combination. As laboratory tests chemical and microscopical analyses, and more particularly the former, have a valuable use when combined with physical tests, but as field tests they can hardly be claimed to have won the right to a place in engineering practice.

Fineness of Grinding.—The desirability of a good test for fineness of grinding is generally urged. Sieves are the only means presented for making tests of fineness, but they do not seem to be regarded as entirely satisfactory. The greatest amount of trouble is had with those for very fine work, owing to irregularity in the mesh in manufacture or by distortion in use, and because of the tediousness of the process of getting the cement through them. No sieve finer than 200 meshes per lineal inch is mentioned in any of the replies, and several of those who answer seem disposed to consider tests with sieves of 50 meshes and 100 meshes amply sufficient for general practice. The diameters of sieves recommended run from 4 ins. to 15 ins., but the diameters preferred by the majority are 6 ins. and 8 ins. The quantity of material to be sifted is variously specified from 1 oz. to 1 lb., but 100 grains, or about 4 ozs., is the quantity preferred by most. The majority prefer hand sifting to sifting by machine, but quite a number advocate the mechanical operation of the sieve. Except that labor is saved by using a machine, no reason seems to be advanced why it should be preferred. In regard to the period of time for which the sieve should be operated for any one sample, the majority make no more definite statement than that it should be until no more cement goes through. The general opinion is that no difference in manipulation is required for fine and coarse sieves, or for different kinds of

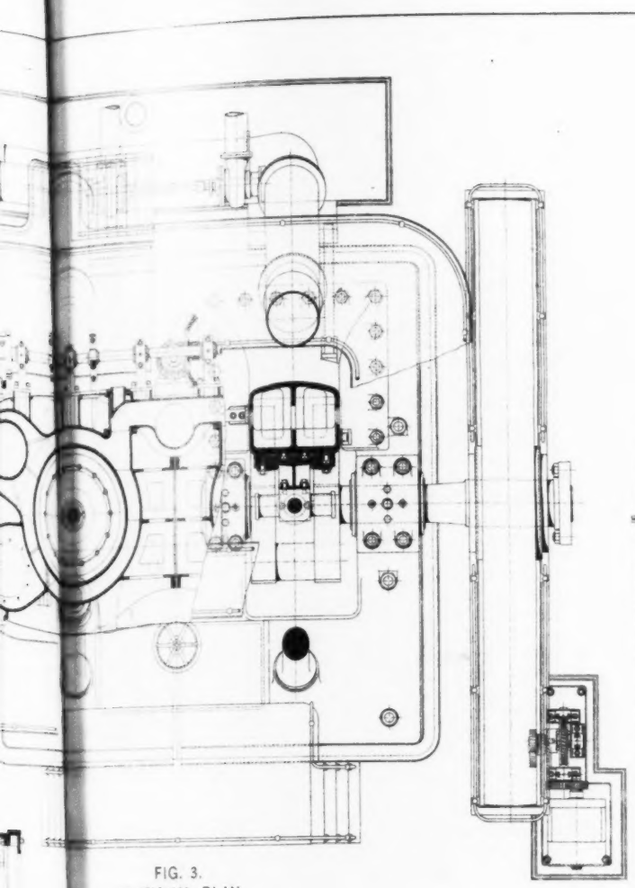
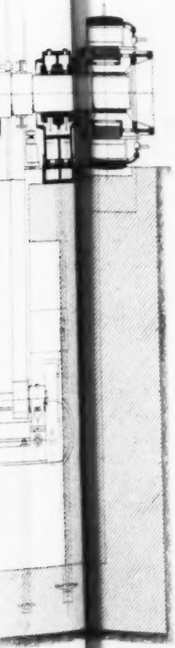


FIG. 3.
SECTIONAL PLAN.



0' 1' 2' 3' 4' 5' 6' 7' 8' 9' 10' 11' 12'

2500 H.-P. TRIPLE EXPANSION ENGINE DIRECT CONNECTED TO ALTERNATOR; PARIS EXPOSITION OF 1900.

A. Borsig, Berlin, Germany,
Builder of Engine.
Siemens & Halske, Berlin, Germany,
Builders of Alternator.

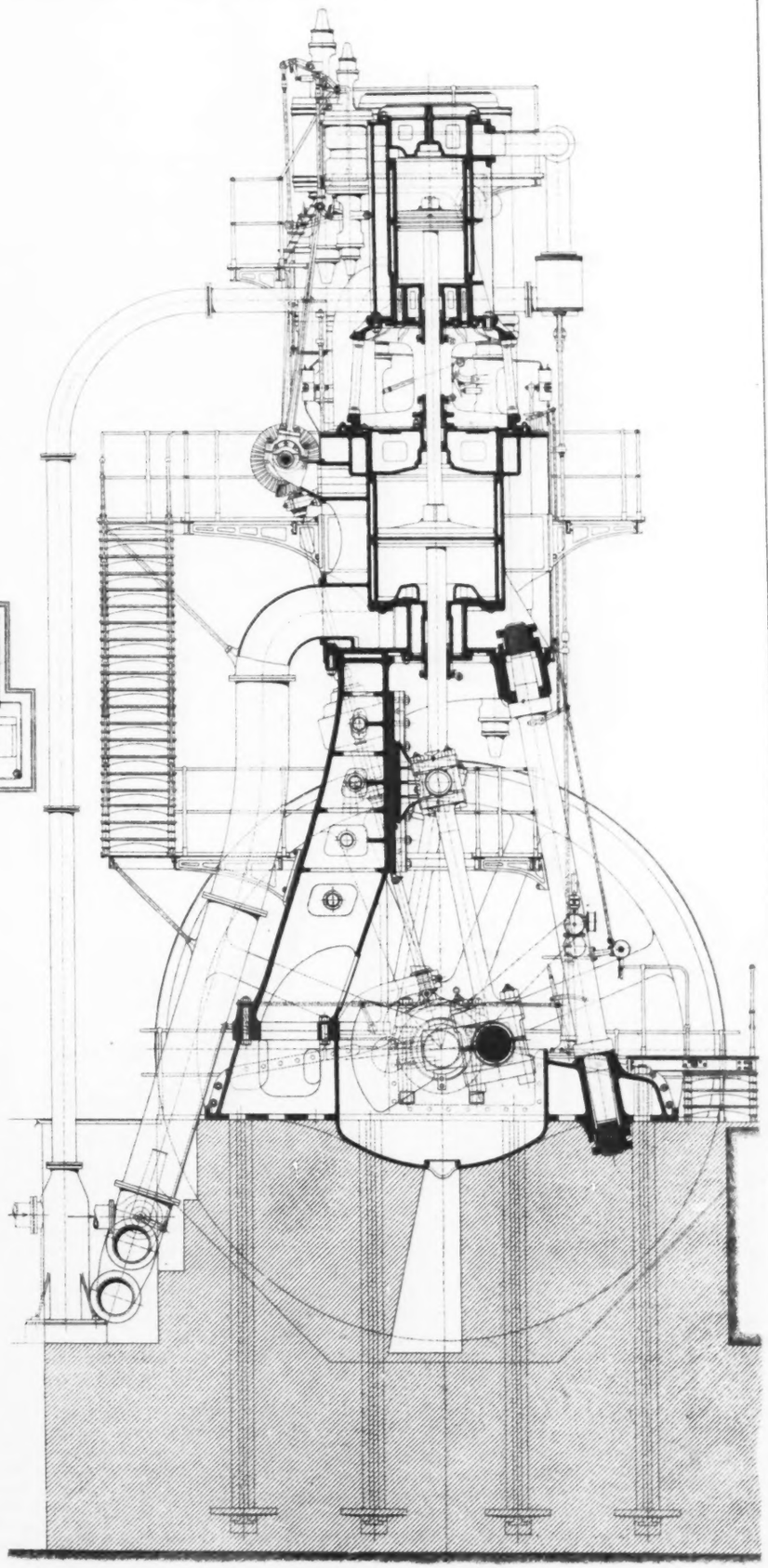


FIG. 1. TRANSVERSE SECTIONAL ELEVATION.

CHAS. HART, LITH., 90 VESEY ST., N. Y.

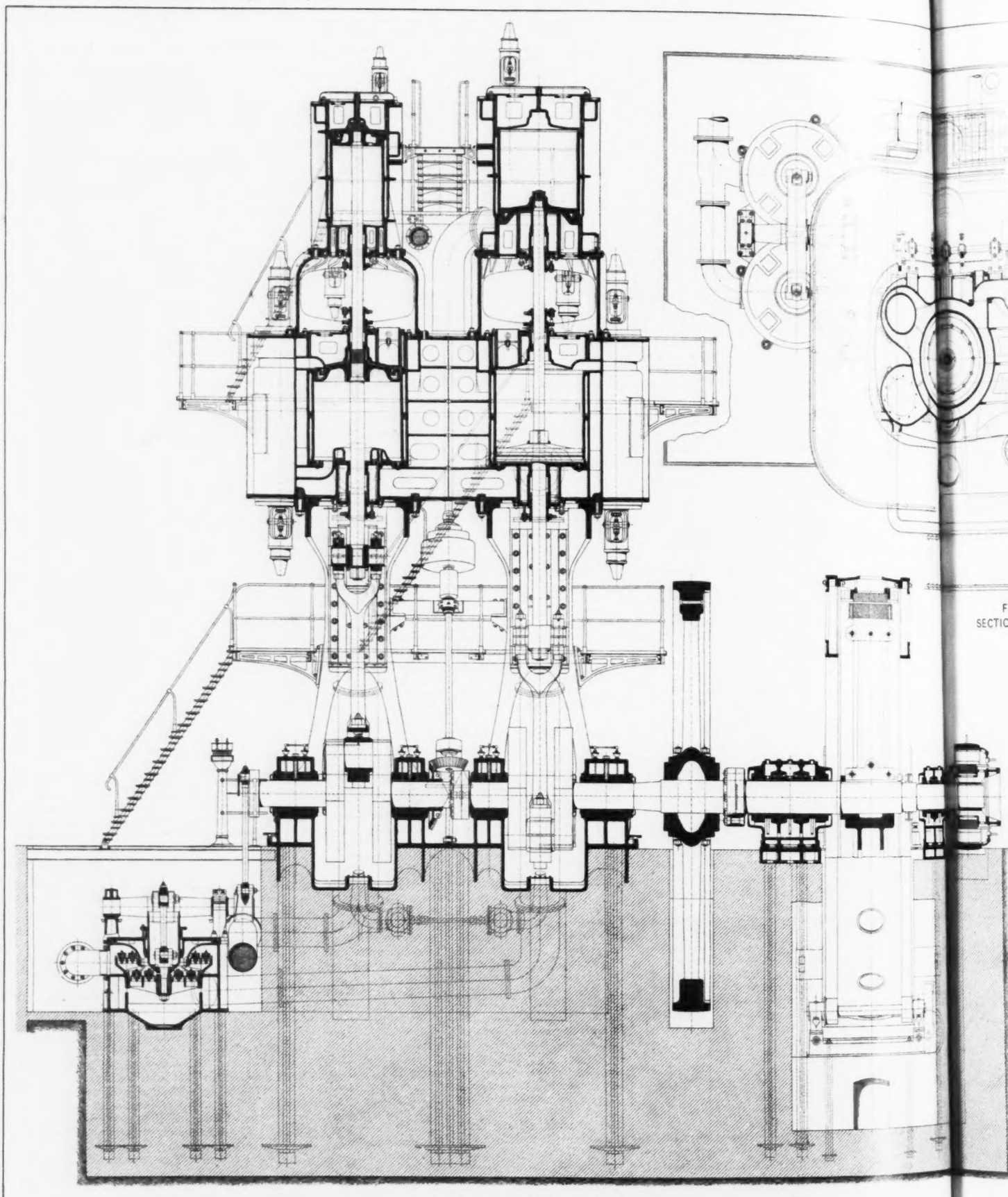


FIG. 2. LONGITUDINAL SECTIONAL ELEVATION.

cement. The suggestion is made, however, by a few that for very fine sieves the cement may be advantageously dried before sifting or stirred up during the process to prevent clogging.

The quite current feeling of dissatisfaction among cement testers with the sieve test for fineness of grinding is pretty well set forth in these replies to the committee's questions, as is also the fact that no satisfactory substitute readily suggests itself. There is no question but that an element of suspicion rests on records of high degrees of fineness in cements which are determined by sieve tests. Just how to get rid of this is a difficult problem. The trouble arises partly from faulty manufacture of the sieves themselves, partly through different methods of manipulating the sifting process, and to some extent probably from the condition of the cement powder. If we contrive to remedy all of these conditions, which we obviously cannot do completely, we are yet encountered by the important objection that the sieve test consumes altogether too much time where the great degree of fineness now commonly demanded by engineers is required to be determined. All things considered, there is little doubt that a generous welcome awaits the invention of a satisfactory apparatus for testing fineness of grinding which can be substituted for the wire sieve.

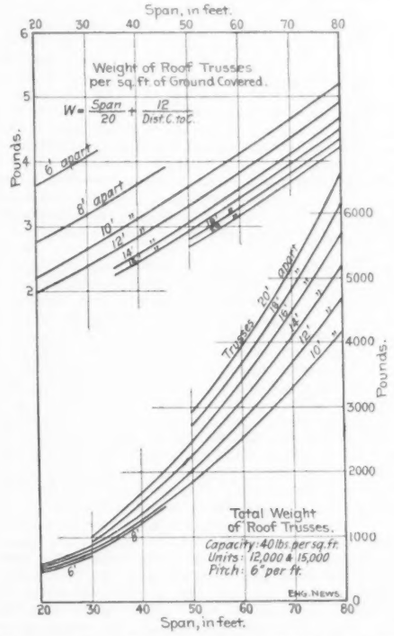
Weight and Specific Gravity.—There is a substantial agreement of the replies to the committee's questions that the weight test for cement is of very little practical value. The specific gravity test is regarded more favorably, but it seems to be favored rather as a laboratory test than as a practical field test. These statements probably express the prevailing opinion among engineers quite fairly. Nevertheless, there is some value to weight tests, and considerably more to specific gravity tests, particularly when they are conducted in combination with other tests.

Turning now to those tests made with cement pastes or mortars, the first matter for consideration is the manufacture of the test mixture. It is scarcely necessary to remark that a great variety of opinion is manifested in the suggestions to the committee regarding this feature of cement testing. In the first place, it should be noted that the bulk of the replies indicate a preference for a stiff paste made with the least amount of water possible which will bring the mixture into a plastic condition. In a few replies the exact amount of water required for different neat cement and sand mixtures is stated, but in most cases no attempt is made to define this quantity exactly, while a number of the replies assert that no absolute specification is possible. Regarding the temperature of the mixing water, and of the atmosphere in which the mixing process is conducted, the replies indicate a preference for between 60° and 80° F. Both hand and machine mixing have their advocates, but the majority prefer the former method. Of those who recommend machine mixing hardly any two agree upon the best form or type of machine to be used.

Time of Setting.—The majority of the replies made to the committee favor the needle test recommended by the society, and now generally used in the United States. A few recommended the German needle test, and two speak favorably of the method of pulling an embedded string through the pats, which was described in Engineering News of Jan. 7, 1897. It seems to be generally agreed that the best way to treat the pats during the test is to keep them covered with a damp cloth.

Soundness.—Probably no form of cement test has received more extended discussion during the last ten years than that for determining the soundness. The replies to the committee's questions respecting this test naturally reflect some of this interest in it, but as a whole they present little which is new. The great majority of them favor the normal cold water test, as, on the whole, the best which has been suggested, although it is recognized that it is by no means without its faults. Regarding the various forms of accelerated tests, the general tendency seems to be to favor those employing the less intense temperatures, such as the hot water test.

Strength.—In testing the physical strength of cement, both tensile and compressive tests are advocated, and several of those who answer the committee's inquiry also favor the employment of bending tests. In making tensile tests the majority of the replies favor adhering to the present form of briquette recommended by the society, and also recommend the molding of the briquette by hand. Only a few of those who suggest machine molding have used molding machines to any extent. The majority recommended the usual practice of removing the briquette from the mold as soon as it has set, storing it in air under a damp cloth for 24 hours, and then immersing it in water until tested. A temperature of about 70° F. for the water in which the briquette is immersed is generally recommended, as is also the frequent renewal of the water, but the latter condition is less generally insisted upon. One and seven-day tests are generally favored, with longer time tests where the first prove doubtful and in other special cases. It is generally held that the weighing of the briquettes before testing gives no information of value. Regarding the best form of dip to be used, the replies generally advocate some form of cushioned clip, with the clip recommended by the society as second in favor. The rate of applying the stress which is generally favored is 400 lbs. per minute. The form of tensile testing machine most favored is the Fairbanks. Several of the replies suggest the advantage of mechanical in place of hand operation of the testing machine.



Diagrams for Determining the Weights of Roof Trusses.

For compression tests the replies are practically unanimous that there should be no difference in the manipulation of the sample, except, perhaps, the exercise of more care in compacting the paste in the cubical mold. Cubes all the way from 1 in. to 12 ins. in size are advocated. The suggestion is generally made that the sides of the cube must either be carefully trued or else cushioned with lead, thick paper, plaster of Paris, cardboard or fine sand. The rate of applying the stress generally recommended is 400 lbs. per minute, but several of the replies suggest a more rapid application.

In regard to the desirability of bending tests opinion appears to be about equally divided for and against it. It is generally agreed that for this test the sample need not be treated differently as regards manipulation of the paste, mixing and setting them are the briquettes for tensile tests. Its chief recommendation, compared with tensile and compressive tests, is the ease with which it can be made, and the simplicity and small cost of the testing machine required.

Regarding tests for adhesion, abrasion, resistance to freezing, etc., the replies are too scattered and vague to permit of being summarized. Broadly speaking, however, the prevailing opinion seems to be that such tests are desirable only under special conditions, in which the information they may furnish has an important bearing on the use of the cement. As tests for the reception of material they do not seem to be generally regarded as of special value. At this point two interesting suggestions which are contained in the replies may be noted. The first of these is that two standard methods of testing cement be adopted, the laboratory test and the field test. The laboratory test should embody all the refinement deemed necessary, and only possible in a well-equipped laboratory, while the field test should be so simple that it can be performed by the ordinary user with simple and cheap apparatus. The second suggestion is that one form of test should be employed for cements of known reliability, and another for new cements.

Reviewing what has been said, the conclusion seems possible that the committee will find its greatest difficulties in devising a satisfactory standard method for testing fineness of grinding, and in specifying a standard mixture for physical strength, soundness and other paste tests. With these matters settled, it would seem that it should be a matter of no very great difficulty to reconcile the variations in practice in other details of cement testing, particularly if the plan for establishing separate laboratory and field tests is followed out.

LETTERS TO THE EDITOR.

Curves for Determining the Weights of Roof Trusses.

Sir: The accompanying curves, to represent the weight of riveted steel Fink roof trusses, will be found convenient in estimating building work. They have been plotted from a series of 146 separate trusses, and represent trusses, complete, with rafter clips and shoe plates, but without ventilators. As seen from the diagram, my formula to represent these curves is

$$\text{Weight per sq. ft. of ground} = \frac{\text{Span}}{20} + \frac{12}{\text{Dist. to curve}}.$$

These curves are now in use by several bridge companies, and have been carefully checked.

As the results of other formulas given by Johnson, Du Bois, Trautwine and Merriman differ from 20 to 60% from these actual weights, it would be interesting to know from what data the others were determined.

H. G. Tyrrell,
Asst. Engineer Boston Bridge Works.

Boston, Mass., May 22, 1900.

Hardwood Pavements in the City of London and in Australian Cities.

Sir: In your issue of May 31 appears a paragraph quoting the London City Engineer, Mr. Ross, on the subject of wood paving for streets. From the statements therein anent hardwood pavement the impression might be gathered that that pavement had proved a failure, as it appears to in the locality named; but the failure was due primarily to an improper method of laying the blocks and possibly in some degree to the wrong timber having been used.

The municipal engineers of Australia, with full knowledge of all kinds of pavings, elected to use hardwood blocking and the pavings of the principal cities of Australia are unsurpassed in the world. The Australian hardwoods only require to be known to be appreciated. With much respect,

E. A. Cullen, Assoc. M. Inst. C. E.,
Engineer Marine Department, Queensland.

Hotel Kenmore, Albany, N. Y., June 1, 1900.

(The note in question was abstracted from a report by Mr. D. J. Ross, City Engineer of London proper (the old city), published in the London "Contract Journal." As we have had a number of letters relating to the note, we state that the report in question was a brief one, equivalent in length to, say, 1½ columns of this journal, in type of the size used for these words. The gist of the report was given in our note, but it contained some detailed figures which we did not reprint.

The amount of human ingenuity expended in attempts to perfect wood pavements is immense. One of the latest "inventions" of this class is called "Jetley's patent wood structure," according to a letter by Lambert Wilson, of Leyton, Essex, Eng., in the "Contract Journal" of May 23. This letter was brought out by the report of Mr. Ross, al-

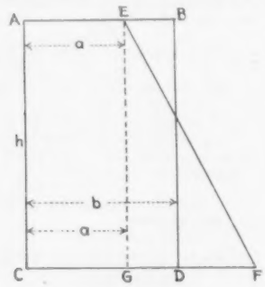
ready noted. Mr. Whitson's description of this pavement is as follows:

Under this system the wood blocks are compressed and combined very powerfully together by machinery, and in such a manner that no block can afterwards move, and it is brought ready made to the street which is to be laid in slabs 4 ft. 6 ins. long and 12 ins. wide, and when the roadway is completed it forms an homogeneous structure from curb to curb so powerful that no block can move and consequently will remain perfectly level. The blocks are laid without any concrete foundation under, therefore all water and impurities can run through into the ground. The roadway when worn down by fair wear and tear can with very little cost in time and labor be turned over, and the slabs will present a level surface and the roadway is practically renewed and will last the same number of years. Another advantage is that by laying the roadway with this structure it takes only as many days as weeks are now required under the present system. This in itself is a great consideration, great annoyance being continually caused by the traffic being blocked for such long periods as they are now. Carlos Place, in Grosvenor Square, was the first trial given this paving. It has now been laid going on for three years, there is no concrete foundation under it, and it is as level as if laid yesterday. But even since then great improvements have been made in the pavement, and I have no doubt that very shortly it will be universally adopted.

In view of the fact that one of the chief causes of the failure of wood pavements, in fact, of pavements of all classes, has been lack of proper foundation, it seems strange to hear any one advocating the laying of pavement directly on the earth; and it is also quite strange to cite as an advantage of this plan that "all water and impurities can run through into the ground." It is to be noted that the thickness of the slabs is not given.—Ed.)

A Conversion Formula for Retaining Walls.

Sir: Having had occasion recently to transform the section of a vertical retaining wall into one of equal stability battered on the face, and not finding a formula for the purpose in any work on the subject which I have consulted, I deduced the following, and finding it quite easy of application, I enclose it herewith in the hope that some of your other readers may find it of value. While Mr. Trautwine's graphic method is quite simple and would probably serve all practical purposes, still I believe there are many engineers who, like myself, prefer to use a mathematical formula, of the correctness of which they



can readily satisfy themselves, rather than the cleverest "rule of thumb" ever devised. The demonstration referred to follows:

Let A B C D be the section of a vertical retaining wall, and A E C F the section of a wall of equal stability, battered on the face E F.

Let h = the height of each wall;
a = the top width of the battered wall;
b = the uniform width of the vertical wall; and
β = the rate of batter, E F, per foot of height;
then the total batter = β h and the width of the base of the battered wall = a + β h.

Draw E G parallel to A C, dividing A E C F into a rectangle and a triangle. Then if g = weight of 1 cu. ft. of the masonry in either wall:

The weight per foot-length of the rectangular part A G = a h g, and its moment about F

$$= a\,h\,g\left[\frac{a}{2}+\beta h\right] = g\,h\left[\frac{a^2}{2}+a\,\beta\,h\right]; \quad (1)$$

The weight of one foot-length of the triangular portion $= g\,h\,\frac{\beta\,h}{2}$ and its moment about F

$$= g\,h\,\frac{\beta\,h}{2}\times\frac{2}{3}\,\beta\,h = g\,h\,\frac{\beta^2\,h^2}{3}. \quad (2)$$

Hence, the sum of these moments will give the total moment M_1 of the battered wall about its toe F, and we have

$$M_1 = g\,h\left[\frac{a^2}{2}+a\,\beta\,h+\frac{\beta^2\,h^2}{3}\right]. \quad (3)$$

Again, the weight per foot of the vertical wall A D = g h b, and its moment about D will be

$$M_2 = g\,h\,b\,\frac{b}{2} = g\,h\,\frac{b^2}{2}. \quad (4)$$

If the walls are of equal stability we shall have $M_1 = M_2$ so

$$g\,h\left[\frac{a^2}{2}+a\,\beta\,h+\frac{\beta^2\,h^2}{3}\right] = g\,h\,\frac{b^2}{2},$$

multiplying both members by $\frac{2}{g\,h}$, $a^2 + 2\,\beta\,h\,a = b^2 - \frac{2}{3}\beta^2\,h^2$, completing the square,

$$a^2 + 2\,\beta\,h\,a + \beta^2\,h^2 = b^2 + \frac{\beta^2\,h^2}{3},$$

and extracting the square root, gives us

$$a + \beta\,h = \pm\sqrt{b^2+\frac{\beta^2\,h^2}{3}}$$

= the width of the base of the battered wall, and

$$a = \pm\sqrt{b^2+\frac{\beta^2\,h^2}{3}} - \beta\,h$$

= the top width of the battered wall. Since our results must be positive, the minus sign before the radical should be neglected. Yours truly,

Frederick M. Thomas.

336 Lafayette Ave., Brooklyn, May 24, 1900.

The Silt Deposit Behind the Austin Dam and the Relation of Silt Deposits to Storage Reservoirs.

Sir: The recent failure of the Austin dam has called attention anew to the heavy deposit of silt in the reservoir back of the dam, which amounted to 41.5% of the capacity of the reservoir in the first four years after the completion of the dam, as determined by Prof. Thos. U. Taylor, of the University of Texas in 1897. The reservoir was a very large one, although small compared with many that have been projected for irrigation purposes in the arid region, and its rapid filling has been used as an argument against the feasibility of storage reservoirs in general as a solution of the irrigation problem. When all the facts are intelligently considered, however, there is nothing unusual or remarkable about this particular case, and certainly nothing about it which should condemn reservoirs in general or discourage the construction of impounding basins of proper proportions relative to the total annual discharge of the streams upon which they are desired to be located.

The Colorado River, above the Austin dam, has a drainage area of 40,000 square miles, from which the run-off prior to the recent flood ranged from a low-water flow of 200 sec. ft., to a flood discharge of 250,000 sec. ft. The mean annual flow for any series of years or for any one year is not definitely known, but reasoning by analogy it may be assumed to reach 50 acre-ft. per sq. mile of drainage area. The Rio Grande and Gila rivers, under somewhat drier conditions, have a mean annual run-off of 25 to 36 acre-ft. per sq. mile, while that of the New York and New England rivers is from 700 to 2,000 acre-ft. per sq. mile. On the assumed basis of 50 acre-ft. run-off per sq. mile per annum the river would have discharged 8,000,000 acre-ft. of water into the reservoir during the four years when the silt was accumulated, or sufficient water to have filled the reservoir 160 times, or 40 times every year on the average. The silt measured by Professor Taylor, though amounting in the aggregate to about 40,000,000 cu. yds., was equivalent to only about 0.25% of the total volume of water probably received into the reservoir during the four years. If the annual run-off be assumed to have been greater than 50 acre-ft. per sq. mile the percentage of silt carried by the water would have been proportionately less than that resulting from the above computation.

One-fourth of 1% is not an excessive load of silt for rivers to carry, and if all the streams of the arid region carried no more than that engineers would have little or no anxiety about the silting of canals or reservoirs. Important, vitally important, reservoirs are being projected on streams that carry many times that ratio of silt, even as high as 16 times as much, and still the projects are considered quite feasible.

The Sweetwater River, Southern California, carries an average of more than 0.5% of silt. Since the construction of the Sweetwater dam in 1887 the stream has delivered to the reservoir about 175,000 acre-ft. of water in all, from which the silt deposit has been about 900 acre-ft., or a trifle more than 0.5%. The ratio between the mean annual run-off of the stream and the capacity of the reservoir in this case was such that the total volume of silt deposited, although high in percentage, is really of little moment as affecting the storage capacity or useful life of the reservoir, as it would take 312 years to fill the basin with silt at the rate of the past 13 years filling. Long before its capacity becomes seriously impaired measures can be taken for enlarging the reservoir or for sluicing out a portion of the silt. It is a problem which is not of pressing interest to the present or the next generation. The Austin reservoir has silted so rapidly merely because its capacity was very small compared with the enormous volume of water annually poured into it from the very large drainage area.

To have had the same life of usefulness as the Sweetwater evidently has the Austin reservoir should have had a capacity of 1,750,000 acre-ft., instead of 53,400. In other words, any reservoir on a silt-bearing stream should have a capacity as nearly equal to the normal mean annual run-off of the stream as possible, or in excess of it, in order to have a maximum life of utility, and postpone to future generations the task of clearing them of accumulations or of building new ones. It is perhaps unnecessary to point out that in the selection of reservoir sites this relation of reservoir capacity to the ratio of silt carried by the mean discharge of the streams needs to be most carefully considered, or to add that small reservoirs on large streams should be avoided, and a proper sense of proportion observed in this as well as in every other feature of the storage problem. Yours very truly,

Jas. D. Sch...

Los Angeles, Cal., June 11, 1900.

Methods of Interpolating Contour Points.

Sir: I note with interest the mass of correspondence in your columns relating to methods of interpolating contour points. All the methods described seek to avoid the tedium of detailed computations by using some form of diagram or apparatus of more or less complicated design. All such apparatus are objectionable, for the reason that they increase the amount of impedimenta to be transported or covering the office table.

Permit me to suggest that the required computations are within the special field of the slide rule. Anyone familiar with this useful instrument (and every engineer ought to be) will readily see that a single setting of the ratio of horizontal distance to vertical difference enables the positions of any number of intervening contour points to be read off with the greatest ease. The slide rule is always at hand, being applicable to a vast number of other uses. Respectfully,

Los Angeles, Cal., May 15, 1900. E. M. B.

Sir: The several communications which have lately appeared in Engineering News concerning different methods of interpolating contour points remind me of a method of locating them on the ground which I devised several years ago while conducting extensive railway surveys in the central part of the Republic of Mexico. I have never seen a published description of this system of contouring, although it has been quite generally adopted at least in that part of the country, and seems to have given general satisfaction.

The only especially designed instrument required for this work is a leveling rod (Fig. 1), to be used in connection with Lock's or other form of hand-level. The peculiar features of the rod consist in placing the zero point of the graduation about 5 ft. from its lower end, and by means of an adjustable shoe this point is made to conform precisely to the height of the eye of the man using the hand-level. The graduation extends both up and down from the zero mark. The height of the levelman's eye and the zero of the rod being equal, they may be considered as the measure of a constant offset line, parallel with the ground surface, and may, therefore, be entirely neglected in the field notes and computations. This reduces the leveling to its simplest form, i. e., the difference between the elevation of the ground at the foot of the levelman and that at the foot of the rod is simply the rod reading as observed through the hand-level.

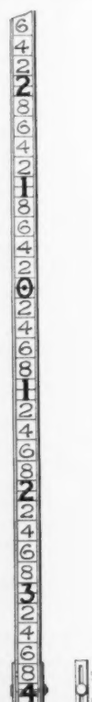


Fig. 1.

Starting a cross-section, or transverse profile at a station, or plus, on the center line survey (Fig. 2), with its elevation taken from the profile or profile notes, the levelman stands by the stake while the contour rod is taken down the slope until, by trial, a point is found where the reading equals the difference between the station elevation (103.2) and that of the first contour below it (El., 100). The distance is then measured and recorded with the elevation of the contour. The levelman then stands at the point just found, while the rod is taken down to the next, and so on. After the desired number of contour points have thus been accurately located the average rate of the slope for some distance beyond is estimated by holding the rod (a little up from the ground, or in a depression, if necessary) in such a position that while the hand-level reads the vertical distance between contours the line of sight produced from the levelman's eye through the zero point on the rod will be approximately parallel to the ground slope. Its rate (horizontal distance per contour), together with the estimated distance to the next pronounced change in the slope, are then noted. This last operation is merely to show generally the topography of a wider strip of country

actually needed for adjusting the details of and for preliminary earthwork estimates.

on the upper side of the center line, the erally goes ahead of the rod. This is espe- ble where grass or brushwood prevents a sight vation near the foot of the rod. By this he notes necessary for plotting the contours at once on the ground without angular com- interpolations.

re work is necessary for locating 5 ft. than for ours, and where deviations from the surveyed be projected on the map they are much more

graphy party is generally furnished a light

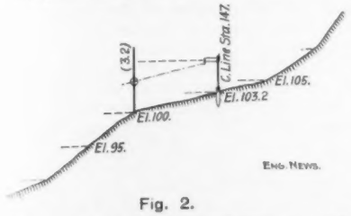


Fig. 2.

compass for locating property lines, etc., and this is used to measure the angles (other than right angles) between the center line of survey and cross-section, for it is often found convenient to locate contour points down the bottom of a ravine or on the crest of a spur. Some prefer to locate these special cross-sections by magnetic bearings.

If a better hand-level than those in general use could be produced with stadia wires for the horizontal distances between contours, the system would be still more satisfactory.

Yours truly,
H. H. Filley, M. Am. Soc. C. E.

Kansas City, Mo., May 21, 1900.

Sir: Allow me to suggest another method for locating intermediate contours between two points of known elevation. The tools required are a slide rule and a scale. Let a and b be the known elevations, c the horizontal distance between them, y the elevation of the contour sought and x the horizontal distance from a to y; then $x = \frac{c}{a-b} \times a - y$. One simple operation of the slide rule will give the value of x for any value of y or (a — y) sought. I use a Sextons amnimeter, and the readings are closer than can be plotted.

Yours respectfully,
Waldo C. Briggs.

Fort Terry, N. Y., May 19, 1900.

Sir: Referring to "Engineer's" letter in Engineering News of May 10, in which the writer suggests an improvement in Mr. Bedell's letter of March 29, I desire to call your attention to a much more simple method than any previously described for interpolating contour points.

The only "instruments" necessary are two pieces of cross-section paper; no dividers, straight-edge or triangle are needed. After the positions of the points and their elevations have been plotted, the "instrument" is oriented by placing the edge of a piece of profile or cross-section paper on a line, joining the two points between which the intermediate contour points are to be interpolated, and with a heavy line of the profile paper opposite one of the points—the one of the higher elevation.

Next, a piece of the same profile paper is marked for a scale with any convenient system. The scale is then placed with one graduation at the edge of the paper, and

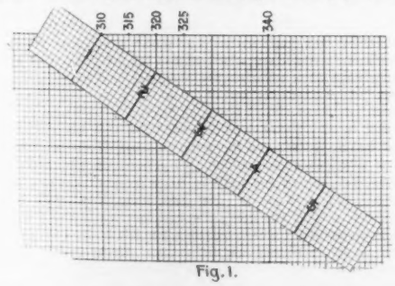


Fig. 1.

at the point of lower elevation; the other end is moved around this point as a center until the proper graduation on the scale coincides with the heavy line of the profile paper. The paper and scale are then fixed so that any contour point can be interpolated by finding that point on the scale and following the vertical line to the edge of the paper. The scale can have several systems of graduations as follows:

Scale No. 1 for "right handed readings," or when the higher elevation is to the right, as in Fig. 1; Scale No. 2 for "left handed readings." Scale No. 3 is for contour points which have a small difference of elevation and are far apart horizontally. Scale No. 4, "left handed reading" for same; Scale No. 5, for contour points, which have a large difference of elevation, and are near each other; Scale No. 6, for "left handed readings" of above.

The scale, in fact, can be changed to suit any case. Green profile paper and graduations in different colored inks are more pleasing to the eye for this monotonous work. This system is far superior, but similar in principle (similarity of triangles) to any I have ever seen. It was originated by myself when at work on the U. S. Deep Waterways survey, and adopted by several of the parties. This survey, as you know, involved the greatest amount of contour interpolation of recent years, and the above described system gave complete satisfaction.

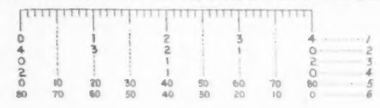


Fig. 2

Very truly yours, H. F. Bascom, C. E.

No. 645 Cherr St., Allentown, Pa., May 11, 1900.

Sir: In your issue of May 10 I note several letters from correspondents explaining similar graphical methods of interpolating contour points. As such interpolation is simply a problem in proportion, it can be quickly and accurately done by means of the slide rule, with which every engineer is doubtless familiar. Taking as an example the problem given by Mr. Daniels in the above issue, let us see how it is applicable to slide-rule computation.

Given the point A of 26.5 ft., elevation, B of 42.8 ft., elevation, and the distance between these points 45.5 ft. To find the distances from point A to contour lines 30 and 40. Note mentally the difference in elevation between the points and scale the distance between them, leaving the scale undisturbed until the proper distances to the required contour lines are read off from the slide rule; point off along the scale from A by pencil or pricker the reading obtained. Using the upper scales of the slide rule usually designated A and B, the operation is as follows:

A | Under 16.3 (diff. of elev. of points A and B).
B | Get 45.5 (distance between points). } then

A | Under 3.5 (diff., elev. bet. point A and contour 30).
B | Find 9.8 ft. (distance from point A to contour 30). } and

A | Under 13.5 (diff., elev. bet. point A and contour 40).
B | Find 37.7 ft. (distance from point A to contour 40).

Obviously the distance between points need not be measured to the scale of the drawing, but any convenient scale may be used.

Yours truly,
H. T. Stiff.

No. 1 Mt. Vernon St., Boston, Mass., May 14, 1900.

Notes and Queries.

The contractors for the Spuyten Duyvil swing bridge of the New York Central & Hudson River R. R., described in our issue of June 14, 1900, were the King Bridge Co., of Cleveland, O.

THE PRIZE DESIGNS FOR THE PROPOSED MEMORIAL BRIDGE ACROSS THE POTOMAC RIVER, AT WASHINGTON, D. C.

The report upon designs for a memorial bridge across the Potomac River, at Washington, D. C., has been submitted to Congress by Gen. John M. Wilson, Chief of Engineers, U. S. A. The board to which these designs were submitted was made up of Lieut.-Col. Charles G. Allen, Major Thomas W. Symons, and Capt. D. D. Gaillard, Corps of Engineers, U. S. A.; and Mr. Stanford White, architect, of New York, and Mr. James G. Hill, architect, of Washington, D. C. The designs submitted to this board included two each by Messrs. L. L. Buck, William R. Hutton and George S. Morison, and three designs by William H. Burr; all of these gentlemen being Members of the American Society of Civil Engineers. The board placed the comparative merit of these designs in the following order:

No. 1. Design No. 2, by Wm. H. Burr.
No. 2. " No. 2, by Wm. R. Hutton.
No. 3. " No. 1, by L. L. Buck.
No. 4. " No. 1, by Geo. S. Morison.

The Chief of Engineers approves of the opinion expressed by the board that the general design of Mr. Burr meets the conditions of the problem, subject to certain modifications as to width, slope of roadway, provision for tram cars, etc. The estimated cost of Mr. Burr's design was $3,680,672; but with the modifications proposed this cost would be raised to $4,860,000.

The question of the construction of a suitable bridge across the Potomac, from Washington to Arlington, has been discussed for the past 15 years. In 1886, Col. Hains, of the Corps of Engineers, made a report and submitted a design costing $609,543 for four spans, or $650,000 for three steel spans; about the same time, Captain (now Major) Symons, Corps of Engineers, U. S. A., also sent in a plan for a memorial bridge, to cost $1,500,000. Under successive action of the U. S. Senate, other plans were submitted, up to March 3, 1899, when plans for a memorial bridge were called for, and the four engineers here named were invited to compete under certain specifications issued by the War Department.

Taking the designs only that are named by the board in their order of merit, we have the following general description of each: Plan No. 2, by Mr. Wm. H. Burr, calls for a single-deck bridge, 60 ft. wide between railings, with two sidewalks each 10 ft. wide. The total length of the bridge is 3,400 ft.; and the bridge proper consists of three 192-ft. span masonry arches; one steel drawspan, with a clear width of 159 ft., and three more 192-ft. span stone arches. These masonry arches are segmental, with a radius of 173.8 ft. and the spring 24 ft. above mean low water. The clear headroom under the arch is 53 ft.; the face of the arch-ring is granite, but the main part of the ring would be built on the Melan principle, with five main concrete-steel ribs. The granite arch-ring would be 5 ft. 6 ins. deep at the crown and 9 ft. 6 ins. at the spring; while the concrete-steel ribs would be 30 ins. deep at the crown and 7 ft. 3 ins. at the spring. The spandrel wall would be partly granite and partly concrete; and the asphalt roadway and granolithic sidewalks would rest on concrete floor arches between I-beams. The weight of this floor was to be carried to the arch-ring by framed steel posts.

The drawspan was of the bascule type, with two arms made of five steel trusses of the lattice girder type. The floor was to be of asphalt cork blocks molded to fit the buckle plates. Two 50-HP. electric motors would operate the draw. The Washington approach was to consist of 12 60-ft. span masonry arches, backed by an earthen embankment 550 ft. long. The Arlington approach included 15 60-ft. arches, with 1,350 lin. ft. of embankment. The perspective view of this bridge shows two very effective memorial arches, resting on massive piers at either end of the drawspan, and surmounted by groups of figures. The total estimated cost is $3,680,672.

Design No. 2, by Mr. William R. Hutton, calls for a single-deck bridge, 60 ft. wide, including two 10-ft. sidewalks. The total length, with approaches, is about 4,000 ft. The bridge proper consists of two 272-ft. steel arches; one steel drawspan, with a clear opening of 134 ft., and two more 272-ft. steel arches. These arches are segmental, with a radius of about 325 ft., and a rise of 35 ft. above the spring. In construction there would be in each span five two-hinged, solid web arch-ribs, about 6 ft. deep, with spandrels of open steel construction. These ribs and posts would support the floor-beams and stringers, which in turn support the buckle-plates carrying an asphalt roadway and granolithic sidewalks.

The drawspan would be a double-leaved, bascule, roller lift bridge, after the patent of Montgomery Waddell; it would be operated by two 50-HP. electric motors. The Washington approach would be made up of six masonry arches; elliptical in form, with spans of 105 ft. and a rise of about 36 ft. The Arlington approach would include six similar masonry arches and four 204-ft steel arches; the latter having a radius of 200 ft. and a rise of 20 ft. There would be two memorial arches at the ends of the drawspan; and ornamental towers marking the principal divisions of the bridge. The estimated total cost of the structure is $5,750,000.

Design No. 1, by Mr. L. L. Buck, is for a single-deck bridge, 80 ft. wide, including two 10-ft. sidewalks, and a central portion of 20 ft. for a double-track street railway. The total length of the structure would be about 3,875 ft. The bridge proper consists, in the order named, of two 100-ft.

granite arches; one 355-ft. steel arch; one steel drawspan with a clear opening of 125 ft.; a second 355-ft. steel arch, and two more of the 100 ft. granite arches.

The masonry arches are segmental, with a span of 100 ft., and rise of 27 ft. The 355-ft. steel arches have a radius of 504.43 ft., and a rise of 32.26 ft. above the spring, giving a clear headroom of 51 ft. at the crown at low water. There would be four two-hinged steel arch-ribs, with the spandrels braced by solid web plates. These ribs carry the floor-beams and stringers; and the latter carry the buckle-plates and the asphalt roadway

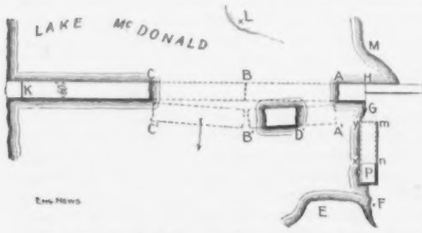


Fig. 2.—Sketch Plan of Break in the Austin Dam. (Repeated from our issue of April 19.)

and granolithic pavements. Each arch-rib is 7.8 ft. deep at the center, and 41 to 39 ft. deep at the ends.

The drawspan consists of two bascule arms supported on trunnions, and counterweighted; it would be operated by two 50-HP. electric motors.

The Washington approach would consist of five 75-ft. granite arches and one 140-ft. granite arch, with an earthen embankment between granite retaining walls for about 600 ft. more. The Arlington approach would include five 75-ft. stone arches, one 140-ft. stone arch, five 75-ft. arches, one 140-ft. arch and five 75-ft. arches, ending with 600 ft. of retaining wall. The 75-ft. stone arches would be full semicircles, with arch-rings 3 ft. thick at the crown and 5 ft. 1 in. at the spring. The 140-ft. granite arches would be segmental, with a rise of 29 ft.; with the arch 6 ft. deep at the crown and 14 ft. at the spring. The principal divisions of the structure would be marked by towers and masses of masonry, surmounted by allegorical groups of statuary. For massive masonry towers, upon the bascule piers, would form the culminating points of the design. The total estimated cost of the bridge is $16,434,230, if the bridge and approaches are finished in six-cut masonry; or $15,409,000, if finished in rock-face masonry.

Design No. 1, by Mr. George S. Morison, calls for a single-deck bridge 80 ft. wide, with two 10-ft. sidewalks. The total length of the structure would be about 4,020 ft. The bridge proper calls for five masonry arches. The span of the central arch is 182.78 ft., and on each side would be arches of 181.38 ft. and the end arches are 177.22 ft. span. The central arch is segmental, with a rise of 45.7 ft. above the spring, and a clear height of 59.4 ft. under the crown. The arch-ring and spandrel walls would be of limestone; with the spandrel pierced transversely by a series of eight small semicircular arches supported on piers 4 ft. thick, resting on the arch-ring. These spandrel arches support the roadway and sidewalks. The other arches are similar in design to this central arch.

Two drawspans would be provided; one at each end of the bridge proper, and each affording a clear opening of 64 ft. These spans would be single-leaf, deck, Scherzer rolling-lift drawbridges. The approaches would consist of skeleton steel viaducts, with solid web, steel floor beams and stringers, resting upon steel posts. They would be in alternating spans of 32.83 ft. and 29.17 ft. Each viaduct would terminate in a masonry abutment, with earthen embankment beyond.

The decorative features consist mainly of four columns, each terminated by a globe surmounted by a bronze eagle, placed on the abutments. The total estimated cost of this bridge is $2,757,264. Mr. Morison also suggests the entire omission of the drawspans, and the substitution of earthen embankments for the open approaches. These modifications would reduce his estimate of cost to $2,084,000.

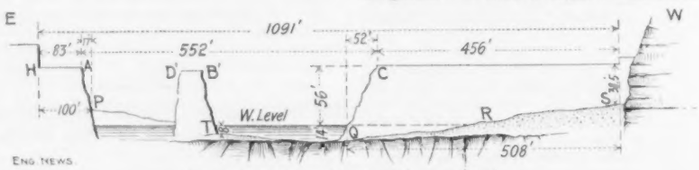
In commenting upon these designs the board says that the low estimate of Mr. Morison is evidently due to the skeleton steel approaches, absence of massive towers and decorative features, and to the use of limestone in the arches. The lowness of Mr. Burr's estimate is ascribed to the use of the Melan arch system; though he proposes arches of 192 ft. of this design, while the longest Melan arch in this country is 125 ft. span. The high estimate of Mr. Buck is largely due to the character of the decorative work and the use of granite. The board favors a width of 80 ft.; for, while it would be desirable to exclude street cars from such a bridge, public opinion may demand this convenience, and it would be better to provide for it.

SOUNDINGS AND MEASUREMENTS AT THE BREAK IN THE AUSTIN DAM.

By Thomas U. Taylor,* Assoc. M. Am. Soc. C. E.

The Colorado River at Austin has maintained such a high flow since the failure of the dam on April 7, that it was impossible to make proper soundings along the broken bed until June 9. On this date the writer took soundings along the present water channel. The water level was 56 ft. below the crest of the dam, as shown in Fig. 1. The water over the foundation near the east end of the western portion now standing was 14 ft. deep. This shows that the present river bed is 70 ft. below the crest of the dam, and that not only is there none of the foundation remaining, but some of the rock foundation has been cut out. The crest of the isolated section, Fig. 2, was found to be 52.1 ft. above the water surface and the water was found to be 8 ft. deep. The bottom, near the west end of this isolated portion, consisted of a formation similar in all respects to the silt deposit in the old lake. The surface of this deposit was 60.1 ft. below the crest of the old dam, and it was impossible to measure it without the use of elaborate methods. It is absolutely certain that no part of the foundation in the present water channel (B C, Fig. 2) remains.

Measuring along the crest of the dam the western part, K C, is 456 ft. long; the eastern part, H A, 83 ft., making the broken part of the crest 552 ft., or 50.6% of the total overfall. The broken line, C Q, Fig. 1, measures 52 ft. horizontally, and A P, 17 ft. The broken part (gap) along P T Q (Fig. 1), is thus 483 ft., or 44.3% of the overfall. The part P T, Fig. 1, is a sand deposit. T Q R is the water level, while R S shows the remains of



The Vertical Scale equals twice the Horizontal Scale.

FIG. 1.—SKETCH ELEVATION OF BREAK IN AUSTIN DAM, AS MEASURED ON JUNE 9, 1900.

the silt. The surface of this at S is at present 38.5 ft. below the crest of the dam. It will be recalled that the soundings taken in January, 1900, and published in the Engineering News of Feb. 22, showed a depth of water from S to Q of 38 ft.

In the area bounded by B L A A^1 × E D^1, Fig. 2, sand to the average depth of 20 ft. is found. Another sand bar has been deposited below K C, Fig. 2. The water is now flowing through B C B^1 C^1, Fig. 2, and has been continuously red or very roily since the break. This is caused by the scouring of the silt by the current. The river has cut temporary banks through this silt, which, being cut under, fall in and serve to keep the stream muddy. The pieces of the broken parts that disintegrated have been distributed all along the river for several hundred yards. The largest collection of these is about 300 yds. below the dam, forming a pool between this and the dam. The water is now 6 ft. above the former low water stage, and it is probable that it will never [illegible] to its former ante-dam level till the shoal allu[illegible] is cut out by a flood.

*Professor of Civil Engineering, University of Texas, Austin, Tex. For previous articles by Professor Taylor, see Eng. News, Feb. 22 (leaks in the dam, etc.), April 19 and May 10, 1900.

THE DISINFECTION OF WATER MAINS W[illegible] CHLORIDE OF LIME.

About two years ago an epidemic of t[illegible] fever occurred at Maidstone, England. It w[illegible] lieved to be due to the pollution of the wate[illegible] ply from typhoid fever patients among a [illegible] of hop-pickers in the gathering grounds [illegible] supply. After the cause of the epidemic w[illegible] cated it was decided to disinfect the water [illegible] both to remove actual danger to the consu[illegible] and to allay their fears. A paper describing [illegible] work was read before the Society of Engin[illegible] a few weeks ago. The paper was prepared j[illegible]ly by Dr. G. Sims Woodhead, a leading English bacteriologist, and Mr. W. J. Ware, and was re[illegible] by the latter. We reprint, nearly in full, an abstract of the paper, which appeared in the London "Surveyor" of April 6, together with an abstract of the discussion:

Owing to the distribution and supply of the Maidstone water, it was a comparatively easy matter to disinfect one part of the system alone; but there were, however, certain drawbacks in connection with the very steep gradients and high pressure at which the sterilizing solution had to be thrown in. After a careful study of the method of sterilizing with dilute milk of lime, as carried out at Worthing, and of Professor Delépine's experiments on chlorine disinfection, it was decided that the mains and service pipes should be filled with chlorinated lime solution in a strength of at least 1%, or 0.5% of the available chlorine. Chloride of lime was used because (1) of its comparative cheapness, (2) of its efficiency as a disinfectant, especially in solution, the double action of chlorine and oxygen being of special importance; (3) under the conditions presented it could easily be obtained in a clear solution of the required strength; (4) it exerted comparatively slight action on lead; (5) its action on leather was supposed to be less than was afterwards found to be the case; (6) the odor could not be mistaken, and there could be no doubt when the chloride of lime had reached its destination; (7) after the pipes had once been washed out there could be not the slightest danger of any ill effects following from the use of chlorinated water.

The high-pressure water was supplied from the Farleigh water (Kentish Rag or Lower Greensand formation), with which surface relations appeared to be easily brought about. It was decided to carry out the disinfecting operations in two sections—A and B. Section A included the company's high-service pressure reservoir and the whole of the distribution mains of the high-pressure area northeast of that reservoir, including about 14¾ miles of mains, with a capacity of a little over 91,000 (U. S.) gallons. In order to obtain a sufficient amount of so[illegible] lution 216,000 (U.S.) gallons of water was left in the reservoir. To that was added 22,400 lbs. of chloride of lime containing 33% of available chlorine. The chloride of lime was thoroughly mixed with the water and then allowed to settle for a couple of hours. The whole of the mains in the high-pressure area were then emptied, and the mains of each of the four districts of the section in turn filled with the chlorinated liquor, the full pressure being maintained for half an hour in each. The entire mains and services of the high-level area were thus charged. After the operation had been completed the remaining solution was used to wash down the roof, walls and piers of the service reservoir. Then, by means of constant stirring, the lime was mixed with the fluid and a milk was formed, which was pumped out from the reservoir by means of a fire engine and run to waste. Two hours after the commencement of operations the chlorine solution was pumped back from the 12-in. trunk mains from the town. The fire engine was again brought into requisition, chlorine water being removed as long as it returned, and two hours later the reservoir was being filled with bright, clear water, free from anything but the merest trace of free chlorine.

In most cases the householders were thoroughly satisfied that chlorinated solution had passed through their service pipes, but there were a few streets in which the occupants of certain houses were not satisfied that [illegible]

had received their full share of the disinfectant. In each of the districts from which complaints were received the service was suspended and the mains emptied. The mains were then charged from the highest point with the filtered solution stored in water vans. The sluice-gates were opened, and the normal pressure was brought to bear to force the solution contained in the mains into the services and fittings of the selected houses. There was some damage to washers, clothing and pumping-gear, but no ill effect of any kind was traceable to the use of the concentrated lime solution. As a result of the treatment every one was satisfied that, so far as the mains and service pipes that conveyed the high-pressure water were concerned, there was no possibility that any typhoid organisms could continue to exist in them.

In section B there were a little over two miles of mains with a total capacity of over 32,000 gallons, with a reservoir having a capacity of 100,000 gallons. That section was treated in exactly the same way as section A, 6,720 lbs. of chloride of lime being added to 60,000 (U.S.) gallons of water left in the reservoir. The process of disinfection was very similar to that adopted in connection with section A. That was the only instance in which disinfection of water mains had been carried out upon anything like so large a scale. The result appeared to have been very satisfactory.

In reply to questions, Mr. Ware stated that there was a little odor to the water from outlying mains for a few days after the disinfection. There were few tanks or storage cisterns in use on the system. He thought the mains were in no way affected by the chloride of lime.

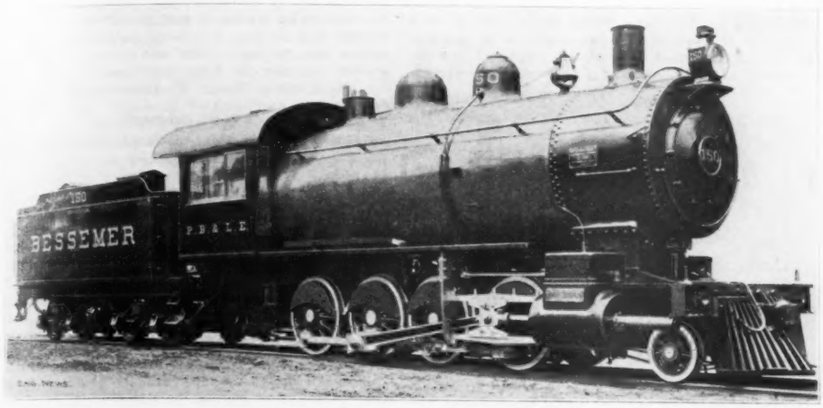
THE HEAVIEST LOCOMOTIVE IN THE WORLD; PITTSBURG, BESSEMER & LAKE ERIE R. R.

We illustrate in the accompanying engraving one of two consolidation locomotives recently completed for the Pittsburg, Bessemer & Lake Erie R. R. This locomotive carries a weight on its drivers of 225,200 lbs.; its total weight being 250,300 lbs., and the combined weight of the engine and tender loaded being 391,400 lbs., or 195.7 tons. In the weight carried on its driving wheels, as well as in its total weight, this new engine surpasses any other locomotives ever built. The engine ranking next in weight and size is the one built for the Illinois Central R. R. in 1899, and its weight and principal dimensions compare with those of the present machine as follows:

	P., B. & L. E.	Illinois Central.
Railway		
Type	Consolidation.	12-wheel.
Name of builder	Pittsburg.	Brooks.
Driving wheels	4 ft. 6 ins.	4 ft. 9 ins.
Wheelbase, driving	15 " 7 "	15 " 9 "
Wheelbase, total	24 " 4 "	26 " 6 "
Weight on drivers	225,000 lbs.	193,200 lbs.
Total	250,300 "	232,200 "
Engine and tender	391,400 "	364,900 "
Cylinders, single	24 x 32 ins.	23 x 30 ins.
Boiler, diameter	7 ft. 4 ins.	6 ft. 8 ins.
Pressure	220 lbs.	210 lbs.
Firebox	11 ft. x 3 ft. 6¼ ins.	11 ft. x 3 ft. 6 ins.
Tubes: Number	406	424
Diameter	2¼ ins.	2 ins.
Length	15 ft.	14 ft. 8⅝ ins.
Heating surf., tubes	3,564 sq. ft.	3,237 sq. ft.
Total	3,805 "	3,500 "
Grate area	36.8 "	37.5 "
Water in tank	7,500 galls.	7,000 galls.
Coal on tender	28,000 lbs.	28,800 lbs.
Data in Eng. News	Present issue.	Oct. 26, 1899.

From the figures furnished us by the builders, the Pittsburg Locomotive Works, of Pittsburg, Pa., we have compiled the following general dimensions in our standard form:

Running Gear: Driving wheels (8), diameter.. 4 ft. 6 ins.
Truck wh'ls(2), 2 ft. 6 ins.; tender wheels(8), 2 " 9 "
Driving wheel centers ..... Cast steel.
Wheelbase: Driving ..... 15 " 7 "
Total engine ..... 24 " 4 "
Engine and tender ..... 37 " 11⅜ "
Weight in Working Order:
On driving whls, 225,200 lbs.; on truck whls, 25,100 lbs.
Engine, total ..... 250,300 "
Tender loaded ..... 141,100 "
Coal on tender ..... 28,000 lbs.



CONSOLIDATION LOCOMOTIVE FOR THE PITTSBURG, BESSEMER & LAKE ERIE R. R.
Pittsburg Locomotive Works, Pittsburg, Pa., Builders.

Cylinder: Diameter and stroke ..... 24 x 32 ins.
Valve Gear:
Ports, steam 20 x 1⅝ ins.; ports, exhaust.... 20 x 2¼ ins.
Bridges, width ..... 1½ "
Slide valves, style, Balanced; max. travel ..... 8 "
" inside lap ..... 0 "
" outside lap ..... 1 in.
" lead (full forward gear) ..... 1-10-in.
Boiler: Type ..... Straight with sloping back end.
Diameter barrel, inside smallest ring..... 6 ft. 9½ ins.
Throat diameter ..... 7 ft. 4 "
Thickness, barrel plates ..... 1 "
Smokebox tube plate ..... ⅝-in.
Horizontal seams ..... Sextuple riveted.
Circumferential seams ..... Double riveted.
Injectors, number ..... Two.
Working steam pressure ..... 220 lbs.
Firebox: Length, inside..11 ft.; width, inside..3 ft. 6¼ ins.
Depth, front..6 ft. 10⅝ ins.; depth, back..5 " 10⅝ "
Thickness, side plates, ⅝-in.; back plate ..... ⅝-in.
Thickness, crown " 7-16-in.; tube plate ..... ½-in.
Kind of crown stays ..... Radial.
Kind of grate bars ..... Cast-iron; rocking.
Water spaces, width at front, back, sides, each... 4 ins.
Tubes: Material ..... Solid drawn steel.
Number 406
Diameter, outside ..... 2¼ ins.
Length over tube plates ..... 15 ft.

Heating Surface and Grate Area:
Heating surface, tubes (interior area) ..... 3,564 sq. ft.
" " firebox ..... 241 "
" " total ..... 3,805 "
Great area ..... 36.8 "
Miscellaneous: Exhaust nozzle, single, diameter... 5¾ ins.
Smokestack, least diameter ..... 17 ins.
" diameter at base ..... 18 "
" height above smokebox ..... 2 ft. 9 "
Capacity of tender tank ..... 7,500 galls.
Brake fittings ..... Westinghouse American.

CENTER PLATES AND SIDE BEARINGS FOR FREIGHT CARS.

At the annual convention of the Master Car Builders' Association, held at Saratoga, June 18 to 20, two committee reports were presented dealing with the questions of center plates and side bearings for freight cars. These subjects, however, are so closely related to one another that we have thought it best to put them together, in order to present a more comprehensive statement of the problems involved in the design and construction of the side and center bearings.

*Report presented at the Saratoga meeting of the Master Car Builders' Association.

Center Plates.

We asked replies to eight questions bearing on the different metals used in center plates, and the general opinion upon the results obtained.

(1) Have you had any trouble with pressed steel center plate?

14 answered: "No trouble experienced so far;" 2, "Trouble caused by rust eating away the metal and breaking through bottom plate where it comes in contact with top center plate;" 20, "Crushing under load; plates too light;" 2, "Use one plate malleable and the other pressed steel, with good results;" 1, "Trouble with steel center plates on wooden bolsters. The bolsters spring and carry the ends of the center plates upward; this causes a rupture around the bearing surface of the plate;" 9, "Lots of trouble, account of being too light. They break the saucer part out and the king bolt wears the hole very fast. The center plates being shallow, there is nothing to resist the shock of switching the cars, therefore it is a common occurrence to knock them off their centers and break the king bolts in doing so. We have had cases where derailment has resulted from badly worn center plates of this make."

(2) Have you had any trouble with malleable center plates?

25 answered: "No trouble at all; good results;" 12, "No trouble after strengthened with ribs and kept oiled;" 4, "Trouble caused by metal being too soft, wearing away fast. Should be fixed to oil; 1, "They bend and break;" 3, Crushing under load—bottom pushed out;" 1, "Would not use malleable iron on any account; too soft."

(3) Have you had any trouble with cast center plates?

20 answered: "They break under the slightest provocation, and believe they furnish the provocation;" 9, "Break easily, unless very heavy;" 20, "No trouble when properly designed;" 1, "They have given us the best results, both on wood and metal bolsters;" 1, "We would not use cast-iron center plates under any condition;" 1, "Have used cast-iron center plates for 20 years and find they cause the least resistance to curving of trucks and hold the cars up better."

(4) Have you any record of center plates becoming ground, or crushed together so that they become fixed?

37 answered: "No trouble from such cause;" 10, "Pressed steel center plates crush together and become locked fast, so that when the car is jacked up the truck is lifted from the rail and you have to use a wedge to separate them. Such a condition might cause a derailment;" 4, "Malleable iron center plates crush under load and have been found, when left on siding very long, with bottom and top center plates amalgamated by rust which would not allow trucks to curve, partially caused by metal being too soft and casting not heavy enough, which in turn was caused by attempting to save metal in construction;" 1, "Have had trouble with cast iron, and in places of deep center plates have found them cut and ground fast so that they would have to be broken to separate top and bottom center plate;" 4, "Both in malleable and cast iron; where cars were left in yard too long, they had rusted to such an extent that they would not curve, which caused derailment."

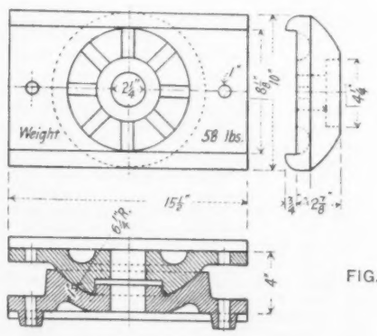


FIG. 1.—BALL OR DISHED-SHAPE CENTER PLATE.

(5) Do you prefer wide faces for center plates?

Three answered showing special designs of center plates of ball or dished shape, one with oiling attachment; also blue print showing construction. These are marked Figs. 1, 2, 3 and 4, and have same merit, deserving careful consideration. 9, "Prefer broad bearing;" 2, "Prefer small center plates, about 5 ins. diameter, for diamond trucks;" 3, "Prefer broad center, plates, about 10 ins. diameter, for swinging bolster trucks;" 10, "Prefer medium of the ball shape, with radius of 10 ins., and about 11 ins. outside diameter, of male bearing;" 2, "Prefer wide bearings, 11 or 12 ins. outside diameter of circle;" 2, "Prefer Pennsylvania standard;" 1, "Believes that for 60,000-lb. cars there should be a surface equal to about 100 sq. ins., and proportionately for other weights;" 13, "Prefer wide surface, 12 or 14 ins. in diameter of male bearing, made flat, for 60,000-lb. cars;" 1, "Prefers small bearing, 8 or 10 ins.;" 1, "Believes the center bearing should have a surface exceeding by one-third the journal-bearing surface, but does not say whether it should be flat or ball-shaped."

(6) Have you any record showing results from frictionless center plates?

2 answered: "Yes, with good results" (see Fig. 5); 1, "Yes; have them in service, but have no reliable data to furnish at present."

(7) Have you record of results from adjustable center plates?

54 answers showed no experience. 1 answered: "Yes, we are using them under our heavy cars with good results."

(8) Can a center plate be constructed that will carry the car body vertically, excepting on curves?

1 answered: "Yes; am using the Royal ball bearing center plate with good results and saving of flange wear;" 3, "Yes, but would prefer frictionless center plate with oiling attachment;" 1, "Yes, like the Pullman pattern;" 3, "Do not think it practicable;" 19, "Yes," and send blue-prints, claiming some of which have been in service for 30 years and made of cast iron.

From the above data the Association can see how varied are the opinions of those constructing or maintaining cars. We feel bound to call attention to those answers wherein the blame or failure of pressed steel or malleable iron castings are attributed to light construction. The steel and malleable center plates crushing under load and becoming so fixed that they will not permit the car trucks to curve, is, we believe, brought about by the excessive length of pressed steel, malleable or cast-iron center plates. It is an established fact that wooden bolsters, or wood and iron combination bolsters, will spring, and it necessarily follows that the long center plate must spring with the bolster. If of light construction, this curvature will necessarily force the outer edges of the center plate inward. This action will nip the bottom section fast, causing a rupture, either by separation of the lower or bearing part of the center plate, or where it curves to form the circle. This would explain the many answers claiming that breakage was due to load, and bottom or top section crushing out. We would advise shortening the bearing of center plate as much as possible, thus reducing the bearing surface lengthwise of the bolster.

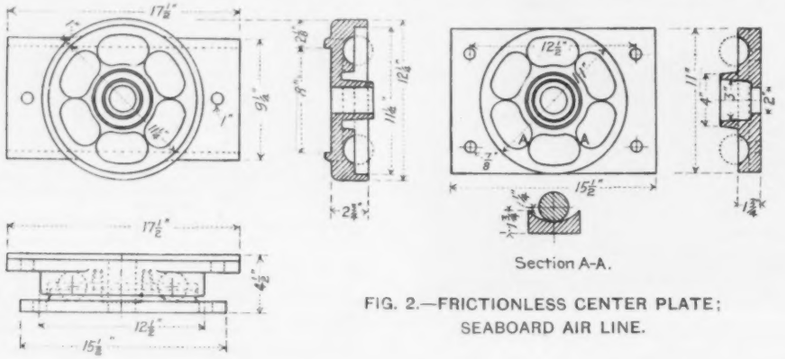


FIG. 2.—FRICTIONLESS CENTER PLATE; SEABOARD AIR LINE.

There should be some relative dimension governed by load for center-plate construction, and without going into a scientific analysis we will call attention to a few conditions that may be readily followed and give reasonably good results. (1) Those loading cars should have impressed upon their minds the importance of loading the cars as evenly as possible, so that the cars will be, as the ship loader would call it, "trim." Assuming that the car is loaded evenly and taking the load on one center plate to be about 40,000 lbs. will give for each foot of width of car about 5,000 lbs. Assuming further, that 400 lbs. per sq. in. of surface should be the general rule for center-plate service, there will be required a center plate about 12 ins. diameter, less the space of 2 ins. for king bolt and 1¼ ins. for inside ring, which would give about 100 sq. ins. for bearing surface. The surface of this center plate being flat, by the aid of an emery wheel it could readily be smoothed off. This would give, comparatively, a smooth surface upon which the 40,000 lbs. would rest. While upon a curve, the natural tendency would be to throw all the weight upon the outer edge of the plate, and the result is that the center of load bearing has moved out 6 ins., resulting in ⅝ of the weight being on one side of the bearing point, equaling about 25,000 lbs. The natural tendency would then be for the car to re-establish its normal or vertical position at the earliest possible moment by overbalancing the remaining ⅜ of the weight on the plate. There would be no question that such a plate would carry the weight of the car and maintain, under reasonable conditions, the vertical position required, thus relieving the side bearings of all duty excepting that of a safety appliance to catch the car in time to prevent damage from any sudden shock in a lateral direction.

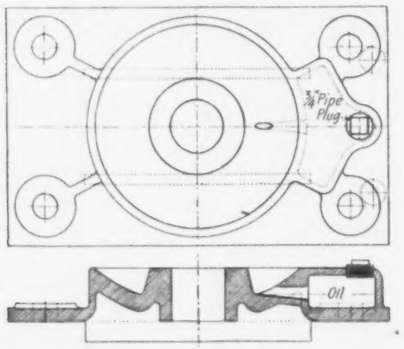


Fig. 3.—Center Plate with Oiling Arrangements.

It is claimed by some that this surface would tend to make the car resist curving, but ordinarily the leverage from center of wheel to edge of center plate would equal the leverage of 5 to 1, and from the fact that the friction is as the weight to the number of inches over which it is distributed would not increase the friction or resist the curving of trucks any more than would the smaller bearing with its greater load per square inch of surface and the leverage proportionately the same. Besides, in real practice, the movement of bottom and top center plate upon each other hardly exceeds, on a 12-in. circle, over 3-16-in., and we have repeatedly sent cars over switches and curves with as high as 18° curvature, marking the center plate and following alongside the car watching the mark, and did not see any movement on the center plate under load even on such extreme curvature. It was found that the adjustment was made more through the agency of the axle and arch bars in 70% of the cases examined than through the convenience or adjustment of the center plates.

Our metal bolster friends claim a large saving in train friction by the use of their bolsters, from the fact that the metal bolster will maintain its general contour under any load, thus assuring, under general conditions, that the car will not ride on its side bearings. Such being the case, on what principle of adjustment do our builders construct a ball or dished-shaped center plate? It is evident that a ball surface or sphere offers the least resistance to a rolling motion, and there is no constructor who would believe that a car, mounted on two 20-in. balls, would maintain its position going around a curve at a rate of 20 miles per hour for as many minutes. That they fear displacement is shown by the construction of a ring at the bottom of the circle that limits, if it does not prevent, the rolling motion that they expected to receive when the ball or center plate was evolved.

As long as the inner ring remains in position, reinforced by the king pin, the car retains its position upon the truck, but should sufficient force be exerted to cause the breaking of this ring, the same force will break the king bolt and cause displacement of the center plates.

Another feature in this construction that is very much in evidence is the listing of the cars to one side bearing, then to the other. With a ball-bearing center plate, if the car should list, what is there to cause the car to assume a vertical position? Must it not remain upon the side bearing until the trucks find some high place on the rail to enable it to toss the car over to the opposite side bearing? If this action is a fact, then is it not also a fact that the car must be literally tossed from one side bearing to the other or remain permanently upon one side bearing, increasing flange wear? As there is nothing to prevent the rolling motion to this ball-bearing center except a tight fit around the center ring or king bolt, what advantage can be claimed in a construction that necessitates a condition to prevent the natural result one must expect from a curve construction, which thus nullifies the advantages that the metal bolster makers claim in their construction of rigid bolsters?

In contradistinction to this ball or dished-shaped center plate, the flat center plate presents many adva... maintaining the vertical position of the car and ... the car to readjust itself, thereby freeing its side ... of all dead weight, offers protection from truck ... ment by its heavy outer ring, assisted by the i... and king bolt, can be kept oiled or greased and ... made smooth with an emery wheel, thus reducing ... to a minimum. Fig. 6 shows the general dimen... a plate for 60,000-lb. cars, having about 100 sq. ... surface to carry about 400 lbs. per sq. in.; also ... in male face to assist the rapid distribution of ... over the face of the male center plate. The oil ... the recesses on the top of said plate from within ... through a ½-in. pipe, and the six holes through ... at the edge of same allow the oil to escape ... grooves and over the lower center plate surface.

R. H. Johnson, George T. Anderson, H. L. ..., Committee.

Side Bearings.

Standard Spreads.—The importance of a standard ... seems to be regarded as secondary to the neces... for clearance. Although this is a feature of much ... ance, it was found that the distance c. to c. of be... as practiced by a large number of companies, d... vary sufficiently to occasion controversy or affe... results in service; the difference being from 53 to ... Less liability to danger would attach to the locati... of side bearings too far from the center of car than ... near, the possibilities of accident from car tipping in... creasing under the latter condition. A correct location would be as nearly over the truck springs as possible, in order satisfactorily to transmit the weight imposed on the bolster. In the common type of freight car truck the springs are located centrally with the arch bars, and the impracticability of placing the side bearings in the same line, by reason of interference with the arch bars, is apparent, except in the case of swing motion trucks. It is therefore believed that the most satisfactory location is just within the arch bars, or about 60 ins. c. to c. of side bearings. A large number of companies at present specify this dimension, and inasmuch as the total variation in nearly all cases is small, there would probably be no difficulty in establishing it as a standard. The fact that this figure cannot be used in all instances with swing motion trucks has not been overlooked; but as a small percentage of the cars being built have this type of truck, it is believed the use of the standard recommended would be but slightly affected.

We would also advocate the adoption of a standard height from top of bottom side bearing to the bearing surface of the bottom center plate. While not affecting the design of the bearing itself, it will permit the interchangeability of trucks where the standards have been observed. The absence of more definite information as to the specifications of the different companies on this point prevents your committee from recommending a height. The advantage of uniformity in these dimensions will readily be perceived, as not only assuring satisfactory results in service, but when the necessity arises of applying trucks to foreign cars for return home, in case of wreck or accident, it will be found applicable, and thus avoid the loss of time and expense necessary in making proper adjustment when there is a difference in these dimensions. In Fig. 7, which shows a body and truck bolster of metal structure, the standard spread as recommended will be found expressed, the letter "A" indicating the height from bearing surface of bottom center plate to the top of bottom side bearings.

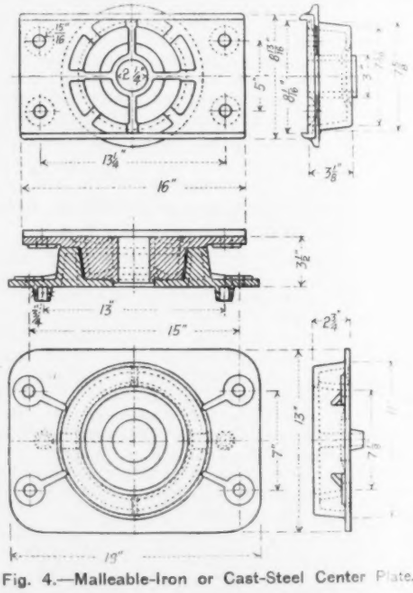


Fig. 4.—Malleable-Iron or Cast-Steel Center Plate.

...g Clearance.—In view of the discussion ...n at different times relating to side bear... and the advisability of carrying the weight ... and load on the center plates entirely, or ...buted on the side bearings and center plates, ...what of a surprise to find expressed in the ...r committee's circulars of inquiry, a unani... in favor of carrying the load on the center ... with one exception) a clearance between the ... advocated. As these recommendations rep... results of long experience, observation and ...ld seem unnecessary to go into lengthy de... relative merits of the two conditions. How... more information, if possible, and confirm ...g opinion, your committee conducted a series ... with a view of determining the relative resistance ... different conditions. A 30-ton box car of late ... used. The body bolsters were of the double ... type, with a 10 × ¾-in. top plate and 10 × ⅞-in. ...plate; the regulation cast-iron thimbles being

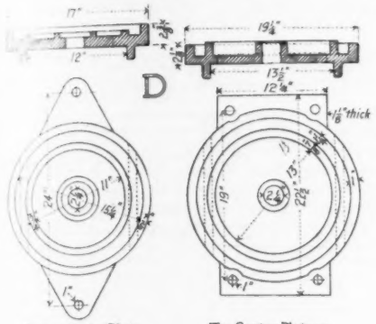


Fig. 5.—Flat Center Plates; Houston & Texas Central Ry.

interposed between the members at the sill bolts, and with a cast-iron filling block at the center. The car had rigid trucks, with Simplex truck bolsters, and a 15-in. channel-iron spring beam. The weight of the empty car was as follows: Body, 18,700 lbs.; trucks, 11,400 lbs.; total, 30,100 lbs. The car was loaded with 100 car wheels, weighing 60,800 lbs.; the weight on each truck being equalized by placing 50 at each end of the car. Adding the weight of the car body will give a total weight of 79,500 lbs. on both center plates. The total area of contact surface of center plates was 56.56 sq. ins., which, with the weight stated, is equivalent to 1,405 lbs. per sq. in. on the bottom center plates, with the car body clear of the side bearings.

An inclined track with a grade of 4%, having a 15° curve at its base and leading to a straight track, was selected to make the tests. In all cases the loaded car was placed on the incline, with the center line of the front pair of wheels at a point 125 ft. from beginning of curve, where it was held with the hand brakes. It will therefore be observed that the car would have a drop of 5 ft. on the inclined tangent, then traversing the curve; the distance traveled on the straight track was recorded as demonstrating the results sought for.

In the first test, the car was adjusted empty to give a clearance of ⅜-in. between each of the side bearings. After the car was loaded there was no appreciable deflection. Thus the entire weight of car body and load, or 79,500 lbs., was imposed on the center plates, that is, 39,750 lbs. at each end. The car was placed on the incline at the point stated; the brakes were released as quickly as possible, whereupon it started and moved rapidly until the curve was reached, where the speed slackened; after reaching the straight track the car resumed its normal position with respect to the side bearings, and traveled 345 ft. before coming to a stop. The rounding of the curve seemed to be attended with but little friction, and in riding on the car there was no perceptible shock or strain.

The height of the side bearings was then adjusted to distribute the weight on the center plates and side bearings as equally as possible. The contact area of the side bearings was 15 sq. ins. each or 60 sq. ins. for the four; adding the area of the center plates gives a total of 116.56 sq. ins. carrying the car body and load, which is 682 lbs. per sq. in. The same procedure was followed as in the previous test, with results given below. In each instance the car rode very hard, and the sudden slackening of speed when the curve was reached produced considerable shock and straining to both body and trucks.

The car was then equipped with anti-friction side bearings having two chilled iron rollers to each bearing, connected with top and bottom seats with chilled surfaces for the movement of the rollers. The adjustment was such as to produce equal weight on center plates and side bearings. The distances traveled with this condition were as stated in the table. The freedom of movement seemed to be about the same as in the first test with clearance between the side bearings.

The car was then raised off the side bearings ⅛-in. This did not result as satisfactorily, as indicated by the distances traveled. There was no difference noticed in the conditions, when the car rounded the curve, compared with the preceding test.

For the convenience of comparison, a table is given herewith summarizing the results of each test, expressed in feet traveled on the straight track after the car had traversed the curve:

	Side bearing clearance. ft.	Weight on side bearings. ft.	Anti-friction, weight on bearings. ft.	Anti-friction, ⅛-in. free. ft.
1st trial	345	203	325	284
2d trial	...	197	335	346
3d trial	...	176	372	303
4th trial	...	212	350	...
Average	345	197	345½	511

Comparison of Tests and Remarks.—The results of the tests would indicate that the most satisfactory condition for service would be to have the weight carried on the center plates, and with a clearance between the side bearings. While the anti-friction bearings under certain conditions produced an average slightly better, the difference is insignificant. Furthermore, it would appear that a correct adjustment is necessary, otherwise the results would not be as satisfactory.

With a clearance between the bearings the car traveled 148 ft., or 75% farther than when the entire weight was equally distributed between the side bearings and center plates. It is, therefore, apparent that a greater force would be required to haul a train in the latter condition; the increased resistance not only entailing additional cost in power, but reflecting an increased cost in flange wear of wheels, wear on the rails and general wear and tear to car body and trucks, due to shocks from unevenness of track, frogs, crossings, etc., occasioning a severer service when the car is down on the side bearings, more so than if the truck had freedom of movement at the side bearings, vertically, as is the case when there is clearance.

The fundamental requirement in maintaining this clearance is a construction of truck and body bolsters which will insure a minimum amount of deflection. Your committee is of the opinion this cannot be obtained with wooden bolsters, as the possibilities of deflection in their use demands a greater clearance at the outset, and which, unless given frequent attention, gradually disappears. It is believed the best results can only be obtained from a good form of metal bolster. In the matter of distance between the top and bottom side bearings, or the clearance, your committee agrees with the majority of the recommendations received, that this should be from ¼ to ⅜-in. with metal bolsters; but it is unnecessary to establish an arbitrary figure, if the amount of clearance approximates the figure stated. With wooden bolsters this dimension should be greater, for the reasons previously stated, or from ½ to ¾-in.

The extent of contact surface of center plates is also considered an important factor as influencing the proper movement of trucks in traversing curves and in relation to the side bearings. It is well understood that safe practice opposes excessive weights for sq. in. of bearing surface; and that better results will be derived from center plates with large area. Those used under the car in making the tests had a bearing area of 28.28 sq. ins. each, producing 1,405 lbs. per sq. in. with a car body and load of the weight stated. Your committee considers this plate too small, and is of the opinion that the size should be such as will impose about 800 lbs. per sq. in. of contact surface.

As to anti-friction side bearings, your committee has not been able to satisfy itself that this type of bearing has attained a sufficient degree of perfection to insure superior results compared with the present practice, considering the increased cost, especially in freight-car construction. Theoretically, a device which will facilitate the movement of the truck when traversing a curve would be of advantage; but from the information obtained, it is demonstrated that the rollers, which enter into the construction of nearly all anti-friction side bearings, soon become flattened and then the bearings are of no more value than the older design, if as good.

Your committee desires to state that after careful investigation and inquiry among a large number of companies, it is convinced that the best results can only be obtained from a proper clearance between the side bearings. In fact, it developed that an important line was refusing cars unless there was such clearance, doubtless an evidence that it is considered a question of safety under some conditions.

J. W. Luttrell, B. Haskell, H. M. Pflager, Committee.

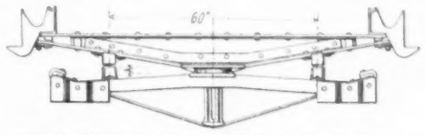


Fig. 7.—Proposed Standard for Side Bearings.

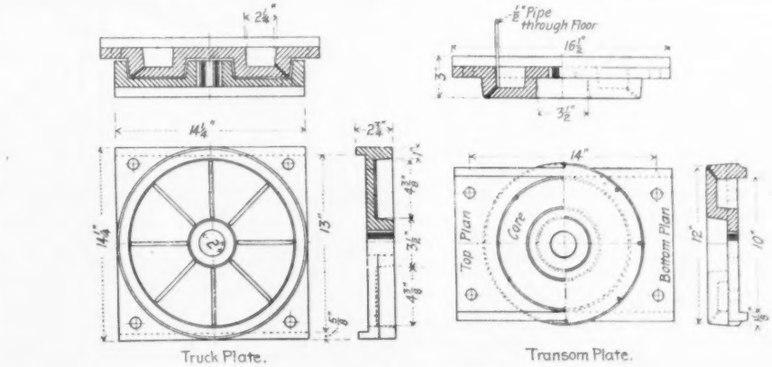


FIG. 6.—CENTER PLATE FOR 60,000-LB. CAR.

COMBINATION BALLAST AND GONDOLA CARS; WISCONSIN CENTRAL RY.

Ballast cars, which are to be unloaded by means of a plow hauled along the train, are usually ordinary flat cars, sometimes fitted with temporary side boards 12 to 14 ins. high in order to increase the capacity. Such cars usually carry about 12 cu. yds. of ballast, or 14 cu. yds. when fitted with the side boards. The standard ballast cars of the Wisconsin Central Ry., however, have a much greater capacity owing to the use of high sides, while they are much longer and of much heavier construction than the ordinary flat cars commonly used for ballast trains. A specially novel feature in their design is the use of side doors for dumping.

These cars, which are shown in the accompanying cuts, are 40 ft. long over the end sills, with a distance of 30 ft. between the truck centers. Fig. 1 shows the details of construction of the car. The framing consists of eight lines of longitudinal sills, with eight lines of truss rods, the middle pair of rods passing through the dead blocks. The needle beams are 10 ins. deep and the struts 10 ins. long, giving a total truss depth of 20 ins. The distance between the struts is 10 ft. On each end sill are two buffer blocks 5½ × 7 × 10 ins., and a deadwood 4 × 10½ ins., 26 ins. long, faced with a steel plate ⅝ × 10 ins. The draft rigging is fitted between the center sills. The floor is of transverse ship-lapped planks, 1¾ × 6 ins., 8 ft. 7½ ins. long, extending a little beyond the side sills.

Stake pockets bolted to the deep 14-in. side sills carry side stakes mortised into top plates 5 × 6 ins. The stakes are 6 ft. 3¾ ins. c. to c., and between them are flap doors or panels, hinged to the top

sills of adjacent cars. There are, of course, no ends or end boards, as the plow has to travel the whole length of the train. When the load is to be dumped, the shaft is turned and the locking dogs are then clear of the hinge straps of the sides. As the plow is hauled along, the pressure of the ballast forces the doors open, swinging outward from the top, and after the plow has passed they return to the closed position, ready for locking.

As the cars have no ends, they cannot, of course, be loaded level full near the ends, but in ordinary service they will carry about 32 cu. yds. of gravel ballast, and they are rated at 100,000 lbs. load capacity. The weight when empty is about 28,000 lbs. The cars are fitted with steel body bolsters, M. C. B. couplers, and air brakes, with the Haskell & Barker trussed metal brakebeam. The brake hand-wheel is placed permanently at one corner of the car, as shown. The trucks are of steel, with diamond frames; top arch bar, 1½ × 4½ ins.; bottom arch bar, 1⅝ × 4½ ins.; tie bars, ⅝ × 4½ ins. The truck bolster is of the Priest & Casey patent form, composed of two 7-in., 17¼-lb. channels, placed back to back, and trussed by a bent 7-in. channel riveted between them. Under each end of the bolster is a nest of four coiled springs seated on the spring plank, which is a 13-in. 39-lb. channel. The springs are 6¼ ins. high when free, and the outside coil is 5¼ ins. diameter, of 1⅛-in. steel. The inside coil is of 9-16-in. steel. The journals are 5¼ × 9 ins. Fig. 2 shows the drawings of the truck, which is designed for cars of 100,000 lbs. and 120,000 lbs. capacity. It is intended later on to build cars of the latter capacity. The general dimensions of the 100,000-lb. cars are as follows:

Length over end sills	40 ft. 0 ins.
Width over side sills	8 " 6 "
Width between stakes	8 " 6 "
Height, rail to top of sill	3 " 8 "
" inside	3 " 4 "
" rail to top of plate	6 " 8 "
Sills: Side (2)	6 × 14 "
" Center (2)	6 × 7 "
" Intermediate (4)	4 × 7 "
" End (2)	8 × 11½ "
Needle beams or cross-tie timbers	5 × 10 "
Side stakes	5 × 5 "
Top plate	5 × 6 "
Truss rods (8)	1⅜ ins.; upset ends 1¾ "
Wheels	2 ft. 9 "
Journals	5¼ × 9 "
Trucks, distance c. to c.	30 ft. 0 "
Wheelbase, truck	5 " 2 "
Wheelbase, total	35 " 2 "
Cubic contents, without ends (gravel ballast)	32 cu. yds.
Cubic contents, with ends (coal)	38 " "
Load capacity	100,000 lbs
Weight of car, empty	28,000 "

These cars are used in grade revision, ballasting and general construction work. When not employed in this service, portable ends are fitted and the side doors locked, forming 40-ft. gondola cars. They are then used in regular freight service for handling coal, lumber, pulp wood, logs, and other material ordinarily carried on flat or gondola cars. The cars and trucks were designed by Mr. Angus Brown, Superintendent of Motive Power and Cars, Wisconsin Central Ry., Waukesha, Wis., and we are indebted to him for plans and other information. The road has now about 250 of these cars, built by the Haskell & Barker Car Co., of Michigan City, Ind.

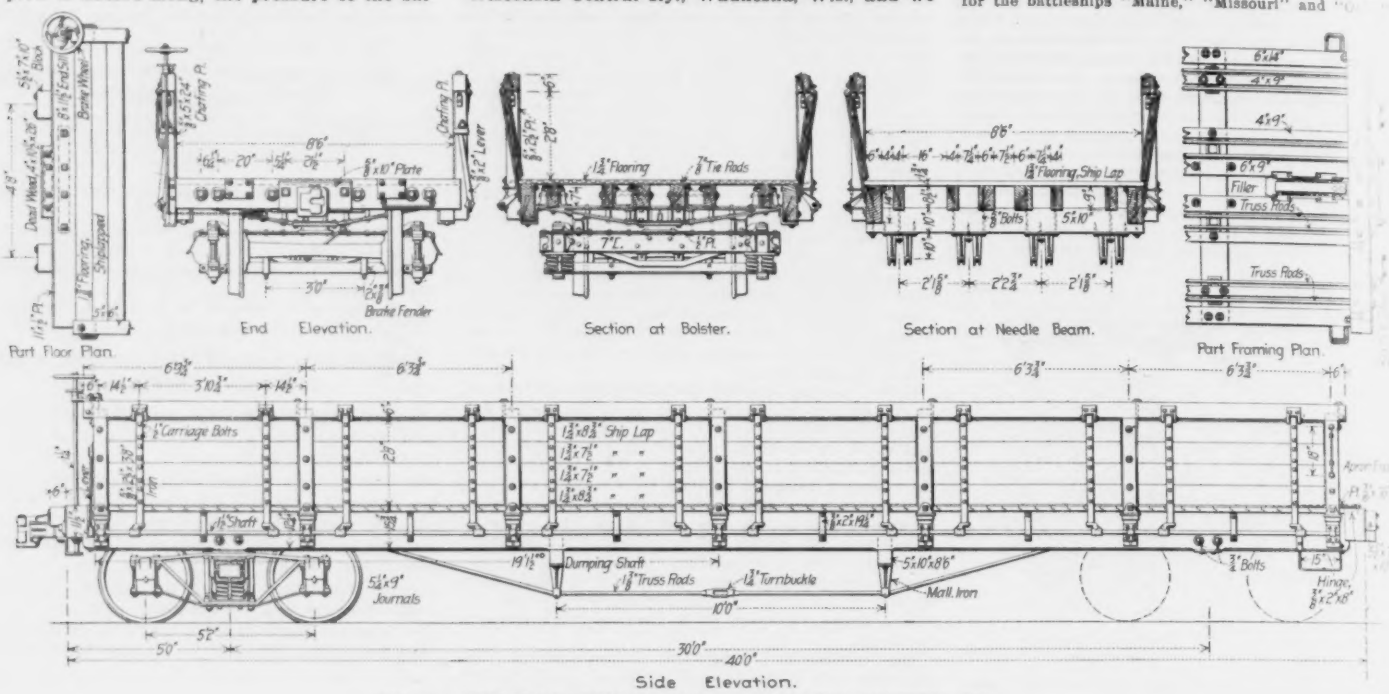
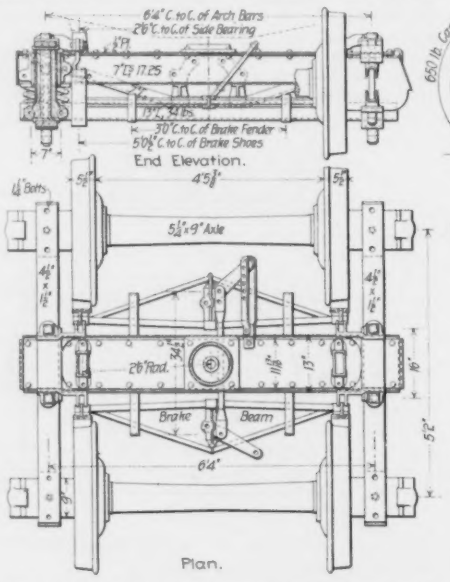


FIG. 1.—100,000-LB. BALLAST CAR; WISCONSIN CENTRAL RY.
Angus Brown, Superintendent of Motive Power and Cars.
Haskell & Barker, Builders.

THE LAKE BORGNE CANAL PROJECT, for connecting New Orleans and Mississippi Sound, is being revived. The "Picayune" points out that with this canal deepened and otherwise improved, New Orleans would have an all-water route from the Alabama coal fields; and will thus have an advantage in shipping coal through the Nicaragua Canal, when built, to the Far East. That journal figures that coal will be one of the largest items of traffic through the canal across the Isthmus, and it estimates that this coal could be sold for $7.50 per ton in all Eastern ports and thus command the market. The improvement of the Lake Borgne Canal presupposes the completion of the improvement of the waterways of Alabama, running to the coal regions; a work upon which the government is now engaged.



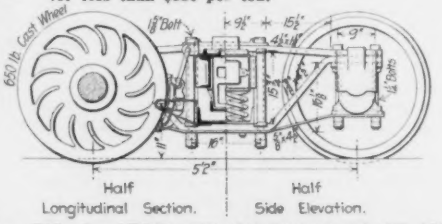


FIG. 2.—STEEL TRUCK FOR CARS OF 100,000 LBS. AND 120,000 LBS. CAPACITY.

THE NAVAL PROGRAMME authorized by Congress calls for an aggregate outlay of $100,000,000. This includes five battleships, with hulls and machinery costing $18,000,000; six heavy armored cruisers, costing for hulls and machinery $25,000,000; 35,000 tons of Krupp armor, which may cost from $17,000,000 to $19,000,000; five Holland submarine boats, to cost $175,000 each, were authorized by the last Congress, and these are to be built within one year after contract. The armor called for is intended for the battleships "Maine," "Missouri" and "Ohio," already well advanced in construction; for the harbor defense monitors "Arkansas," "Connecticut," "Florida" and "Wyoming," also under construction; for the battleships "Georgia," "New Jersey" and "Pennsylvania," and three others not yet named, and the armored cruisers "California," "Nebraska" and "West Virginia." Bids for this armor are to be asked for shortly; and it is believed that proposals for the lighter armor will come from many smaller establishments at rates below $500 per ton. As to the heavier side-armor, the Carnegie and Bethlehem companies alone have the necessary plant for manufacture, and it yet remains to be seen what they will do; these firms claim that the heavier armor cannot be made for less than $550 per ton.

UNIFORM LABOR LAWS are provided for in a report to Congress prepared by the National Industrial Commission. Uniform State legislation is recommended limiting the hours of labor of minors in factories and prohibiting the employment of those under fourteen years of age. National legislation is also recommended fixing the length of a working day as eight hours in all work done for the government, and limiting the hours of labor by all railway employees engaged in interstate commerce. A representative of several of the railway brotherhoods has submitted the following schedule of legislation desired by railway employes: Legislation compelling railroad companies to publicly post their rules and rates of wages; to allow employes accused of any offense to know all the evidence against them, and, if discharged, to give them, in writing, specific reasons therefor; to do away with "black-listing," by making it unlawful for a railroad company to furnish the record of an employe to another company; to secure legislation for an eight-hour day; to forbid the running of Sunday trains on all interstate roads, except in the case of relief and wreck trains, and to allow trainmen to complete their trips so as to arrive at home on Sunday; to give employes of railroads the same right to recover damages for injury as is enjoyed by those who are not connected with such roads; to legislate out of existence railroad relief associations.